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SATURN V/LOR VEHICLE MAXIMUM HEATING TRAJECTORY

1 MARCH 1965
DOUGLAS REPORT SM-46738

MISSILE & SPACE SYSTEMS DIVISION
DOUGLAS AIRCRAFT COMPANY, INC.
SANTA MONICA/CALIFORNIA

DOUGLAS

[redacted]

CONFIDENTIAL

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MAXIMUM HEATING TRAJECTORY

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PREFACE

This study was conducted for NASA under contract number NAS7-101, Change Order 158, as described in Technical Directive I-V-S-IVB-TD-64-42, by the Douglas Aircraft Company, Space Systems Center, from February through July 1964.

ABSTRACT

This report presents a statistically derived, dispersed trajectory simulation of the atmospheric boost for the Saturn V launch vehicle which results in the maximum skin temperature due to aerodynamic heating at a selected location. It may be used as a design criterion for the purpose of redefining the aerodynamic heating on the Saturn V/LOR vehicle. To obtain this trajectory, the vehicle's first stage performance parameters, the atmosphere, and winds were perturbed. Only those factors which significantly affected skin temperatures were perturbed in constructing the trajectory. The relative effect on temperature of each of these factors is presented.

DESCRIPTORS

Saturn V/LOR Mission

Design Trajectory

Aerodynamic Heating

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1.0 INTRODUCTION

Up to the present, the structural design criteria for the Saturn V boost vehicle dictate that skin temperature be determined using a NASA-derived nominal trajectory with virtually zero angle of attack during maximum heating. The nominal trajectory was established by the utilization of nominal values of performance parameters (i.e., propulsion system, propellant and structure weights, control system characteristics, aerodynamic characteristics and atmospheric models) and zero wind speed. Because it is not possible to predict the exact flight history of any performance parameter prior to flight, it is necessary to establish flight history envelopes for the parameters. To allow for the probable deviations of performance parameters from their nominal values during flight, a trajectory simulation yielding skin temperatures of a prescribed probability-of-occurrence, was derived. This derivation was accomplished by generating a set of non-nominal trajectories in which the parameters were varied, individually, above and below their nominal values. The peak skin temperatures of each of these trajectories were compared to that of the nominal trajectory and the differences noted. By statistically combining (root-sum-square, RSS) these peak temperature differences, a maximum expected temperature difference from the nominal was computed. However, in determining the trajectory which results in this computed temperature difference from nominal, only those parameters which had a significant effect on the skin temperature were used.

This trajectory will yield a realistic (3σ probability-of-occurrence) maximum skin temperature rise above the nominal for key design locations on the vehicle. It may be used as a design criterion for the purpose of redefining the aerodynamic heating on the Saturn V/LOR vehicle.

2.0 ASSUMPTIONS

2.1 Vehicle

The nominal vehicle used was the Saturn V/LOR vehicle as presented in Reference 1 and as shown in Figure 1. The nominal vehicle weights as shown in Table I are from Reference 2. The engine performance data shown in Table II are also from Reference 2. The aerodynamic force data for this vehicle were taken from Reference 3.

As these vehicle parameters will tend to deviate from their nominal values due to manufacturing tolerances, weighing inaccuracies, etc., it is assumed that these deviations are independent of one another and have a Gaussian probability distribution about their nominal values. Table III lists the vehicle parameters considered and three sigma deviations from their nominal values.

2.2 Trajectory

A three-dimensional simulation of the nominal Saturn V/LOR mission trajectory (Reference 2) was generated to establish a reference, or baseline, to which perturbations could be applied. The simulation was constructed with the aid of an IBM 7094 computer program using a point mass solution and a rotating oblate earth. This DAC nominal trajectory simulation (corresponding closely to that of Reference 2) is presented in Table IV (the list of symbols should be referred to for trajectory interpretation). It assumes a vehicle launch from the Eastern Test Range (formerly AMR) with an initial azimuth of 70 degrees east of north. Any deviations from the mentioned nominal trajectory will require further evaluation.

2.3 Environmental

The nominal atmosphere model used for this study is presented in Reference 4. As no deviated atmosphere model was available, deviations of the state parameters were taken from Reference 5, pages 20, 85, and 86. Atmospheric density was assumed to be the independent variable and the pressure and temperature were assumed to be dependent. As preliminary investigations indicated that the pressure had the greater effect on skin temperature, the study was simplified by assuming that atmospheric temperature retained its nominal values while the density and pressure varied. The density extremes (Reference 5) were assumed to be 3σ extremes with a normal probability distribution. The pressure was then computed using the equation of state for an ideal gas. The density and pressure models determined by this method are shown in Figures 2 and 3. Also included are the atmosphere assumed for the final "3σ hot" trajectory (defined in the same manner) and the Patrick AFB atmoshpere.

The nominal trajectory assumes no winds. The winds are from Reference 5, pages 45 and 60. The contractually specified 95 percent probability evelope (95 percent probability of not being exceeded) was used as a head wind and is shown in Figure 4.

2.4 Aerodynamic Heating

In the determination of the skin temperatures for the nominal and each of the perturbed trajectories, the following flow field and heat transfer assumptions were made:

1. The vehicle boundary layer is always turbulent and has experienced no separation.

2. The flow field passing over the cylindrical section of the S-IVB stage has experienced two previous conical shock waves, one generated by the Service Module and the other by the LEM adapter. In both cases, the flow behind the conical shock waves was expanded to zero pressure coefficient. For the aft interstage of the S-IVB stage, the aforementioned flow field was passed through a third conical shock wave and expanded to the local slope of the aft interstage.

3. Only heating on the windward side of the vehicle was considered.

4. A thin skin solution was obtained; that is, it was assumed that no temperature gradient existed along or through the skin.

From an aerodynamic heating standpoint, the Saturn V/LOR vehicle was considered to be a series of cones and flat plates, protuberances excluded. The cylindrical portions of the vehicle may be considered as flat plates, because their diameter is large compared to the boundary layer thickness. The heat transfer to a conical surface is directly related to that of a flat plate and the heat transfer in the vicinity of protuberances is experimently determined as a function of flat plate heat transfer.

Heat transfer on the surface of a protuberance is dependent on geometry, boundary layer thickness to protuberance height ratio, local Reynolds number and Mach number. At the present time, there are no heat transfer theory or empirical relationships for protuberance heating. However, since

the same parameters that affect flat plate heat transfer govern the heat transfer on protuberances, it may be hypothesized that protuberance heat transfer may be related to flat plate heat transfer. Since the heat transfer to the vehicle surface is dependent on flat plate heat transfer theory, a maximum heating trajectory for the vehicle will be obtained if the heating of any location is maximized.

3.0 ANALYSIS

3.1 Parameter Effects

The basic assumption of parameter independence allows that each parameter deviation effect be examined separately. In accomplishing this, a set of trajectories was computed for several values (including $\pm 3\sigma$) of parameter deviations for each parameter. These trajectories were then analyzed for aerodynamic heating. The peak skin temperatures were compared to the peak skin temperatures from the nominal trajectory. Figure 5 illustrates the relative effects of the various parameters.

3.2 Aerodynamic Heating

The location selected for analysis is on the S-IVB Aft Interstage just aft of station 2746.55. The aerodynamic heating analysis was accomplished with the aid of an IBM 7094 high speed digital computer program. The nominal and perturbed trajectory information (free-stream velocity, ambient temperature and pressure, and angle of attack) were input data for the program. The analysis was accomplished in three distinct steps:

1. Computation of the local properties of air outside of the boundary layer at the point of investigation (Reference 6).

2. Computation of the heat transfer coefficients (Reference 7).

3. Computation of the thin skin temperature.

3.3 Maximum Heating Computations

It was found that all parameter deviations had nearly constant partial derivatives of temperature with respect to parameter deviation over the range examined. This, combined with the original assumption of Gaussian distribution about the nominal parameter value, led to a statistical combination of the individual 3σ temperature effects by the use of root-sum-square (RSS) addition to obtain a 3σ maximum peak skin temperature. Mathematically, for the location selected,

$$\Delta T_{3\sigma_i} = \left[\left(\frac{\partial T_i}{\partial \phi_1} \Delta\phi_1 \right)^2 + \left(\frac{\partial T_i}{\partial \phi_2} \phi_2 \right)^2 + \ldots + \left(\frac{\partial T_i}{\partial \phi_n} \phi_n \right)^2 \right]^{1/2}$$

3.4 Three Sigma Trajectory

There are an infinite number of combinations of the input parameters, i.e., an infinite number of trajectories, which would yield the desired 3σ temperature. Algebraically combining the individual 3σ dispersions will result in a temperature which will exceed the increase indicated by the RSS combination (3σ). Therefore, it is necessary to combine the parameter deviations in such a manner as to obtain a trajectory simulation which would result in the 3σ difference in temperature. To generate this trajectory, an equal probability-of-occurrence was assumed for each of the

parameters. To determine the sigma level (for each parameter) which when algebraically combined will result in the trajectory giving the 3σ (RSS value) temperature rise, a number of sigma levels were investigated. Through the interpretation of these results (Figure 6), a sigma level was determined which results in the "3σ hot" trajectory (Table V).

4.0 DISCUSSION OF RESULTS

4.1 Individual Effects

A review of the individual parameter effects on peak temperature reveals that six of the parameters essentially control the vehicle temperatures. Of these, the atmospheric density has the greatest influence. The relative effects of these six parameters on the aft interstage skin temperature are shown in Figure 5. The remaining parameters, including specific impulse and center of gravity, were found to have virtually no effect on temperature.

4.2 Combined Effects

Combining the individual 3σ temperature differences by root-sum-square gave an increase of 55.2°F. Referring to Figure 5, the $\Delta T_{3\sigma}$ value is shown as the maximum value on the curve. Table V presents the "3σ hot" trajectory simulation which results from the use of the sigma level shown in Figure 6.

5.0 CONCLUSIONS

As the aerodynamic heating calculations used for the aft interstage location are generally applicable to the entire vehicle, it can be concluded that the trajectory which yields maximum skin temperature on the point investigated will yield maximum skin temperatures for any other vehicle location. Several slightly conservative assumptions were used in this study and it is felt that the final trajectory ("3σ hot") is also slightly conservative (hot).

It should be noted that while this trajectory is generally applicable to any point on the vehicle for the assumed deviations from the nominal trajectory, any change in the nominal trajectory assumptions or in the deviations assumed will require further study.

REFERENCES

1. MSFC Drawing, 10M04106, Revision G.

2. MSFC Memorandum, M-P&VE-V-33, "Saturn I, IB and V Launch Vehicle Specifications Weights and Compatible Trajectories," Weight and Performance Review Board, dated May 13, 1963 (C).

3. MSFC Branch Working Paper, 62/3, "C-5 Performance Summary," dated July 15, 1962 (C).

4. TND-595, A Reference Atmosphere for Patrick Air Force Base, Florida, O. E. Smith, dated March, 1961 (U).

5. MSFC Memorandum, MPT-AERO-63-8, "Natural Environment (Climatic) Criteria Guidelines for Use in MSFC Launch Vehicle Development, 1963 Edition," G. E. Daniels, dated January 28, 1963 (U).

6. NACA Report, 1135, Equations, Tables and Charts for Compressible Flow, Ames Research Staff, 1953 (U).

7. Van Driest, E. R., "The Problem of Aerodynamic Heating," Aeronautical Engineering Review, Volume 15, No. 10, October, 1956 (U).

LIST OF SYMBOLS

IBM 7094 PROGRAM AA63

MAIN PRINTOUT

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
A SB XB	$a_{xB'}$ $a_{yB'}$ $a_{zB'}$	Components of acceleration along the vehicle axes: positive forward along vehicle centerline; normal to the vehicle pitch plane, to the right; and down, respectively, ft/sec^2.
A*SB 1	A*	Radar azimuth angle: angle between the radar site meridian and the projection of the radar line of sight onto the plane tangent to the surface of the earth at the radar site, positive clockwise from north, deg.
ALPHA SB P	α	Pitch angle of attack; angle between the projection of the relative air velocity vector onto the vehicle pitch plane and the centerline of the vehicle, positive nose up, deg.
ALPHA	α'	Total angle of attack: angle between the relative air velocity vector and The vehicle centerline, deg.
ALPHA*Q	$q\ \alpha'$	Product of total angle of attack and dynamic pressure, $deg\text{-}lb/ft^2$.
ALTITUDE	h	Vehicle altitude: distance above mean sea level meawured along the normal to the earth's surfact (oblate spheroid) positive up, ft or n mi.

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
ALPHA SB Y	β	Yaw angle of attack: angle between the projection of the relative air velocity vector onto the vehicle yaw plane and the centerline of the vehicle, positive nose left, deg.
BETA SB L*	β'_L	Difference between vehicle centerline azimuth angle, ψ'_L, and the inertial flight path azimuth angle, γ'_{2I}, positive for $\gamma'_{2I} > \psi'_L$, deg.
CHORD FORCE	C	Aerodynamic force directed along the vehicle centerline opposing vehicle motion, lb.
D* SB1	D*	Radar slant range: straight line distance from radar site to vehicle, ft.
D-D STAR X	$\dot{D}^*_x$	Component of vehicle earth-fixed velocity, along the radar line of sight, ft/sec.
DELTA SB Y	Δ_y	Motor yaw deflection angle: angle between the thrust vector and the vehicle pitch plane, positive nose left, deg.
DELTA SB Z	Δ_z	Motor pitch deflection angle: angle between the projection of the thrust vector onto the vehicle pitch plane and the vehicle centerline, positive nose up, deg.
E* SB1	E*	Radar elevation angle: angle between the radar line of sight and the plane tangent to the earth's surface at the radar site, positive for vehicle above radar tangent plane, deg.

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
ETA SB 1	η_1	Instantaneous azimuth angle: angle between the launch site meridian and the plane perpendicular to the surface of the earth at the launch site containing the vehicle, positive clockwise from north, deg.
F SB X F SB Y F SB Z	F_x, F_y, F_z	Thrust components in vehicle coordinates: F_x positive forward, positive F_y yaws nose to the left, positive F_z pitches nose up, lb.
G SB L*	$g_{L'}$	Total resultant gravity vector due to attractive force of the earth measured in the x'_L, y'_L, z'_L coordinate system, ft/sec^2.
G SB XL* G SB ZL*	$g_{xL'}$, $g_{zL'}$	Components of gravity due to attractive force of the earth measured in a coordinate system where x'_L is positive north, y'_L is positive east, and z'_L is positive toward the center of the earth along a line connecting the vehicle and the earth's center, ft/sec^2.
GAMMA (Z)	γ_z	Flight path elevation angle, non-inertial: angle between the rotating earth velocity vector, $\bar{V}_e$, and the launch tangent (x-y) plane, positive for vehicle moving in the direction of the minus z axis, deg.
GAMMA SB 1	γ_1	Flight path elevation angle, non-inertial: angle between the rotating earth velocity vector, $\bar{V}_e$, and the local tangent plane, positive for vehicle moving away from the earth, deg.

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
GAMMA SB 1I	γ_{1I}	Flight path elevation angle, inertial: angle between the total inertial velocity vector, $\bar{V}_I$, and the local tangent plane, positive for vehicle moving away from the earth, deg.
GAMMA (1I)PR.	γ'_{1I}	Flight path elevation angle, inertial: angle between the total inertial velocity vector, $\bar{V}_I$, and a plane perpendicular to the radius vector from the center of the earth to the vehicle positive for vehicle moving away from the earth, deg.
GAMMA SB 2	γ_2	Flight path azimuth angle, non-inertial: angle between the local (instantaneous) meridian and the projection of the rotating earth relative velocity vector, $\bar{V}_e$, onto the local tangent plane, positive clockwise from true north, deg.
GAMMA SB 2I	γ_{2I}	Flight path azimuth angle, inertial: angle between the local meridian and the projection of the total velocity vector, $\bar{V}_I$, onto the local tangent plane, positive clockwise from true north, deg.
GAMMA (2I)Pr.	γ'_{2I}	Flight path azimuth angle, inertial: angle between the local meridian and the projection of the total velocity vector, $\bar{V}_I$, onto a plane perpendicular to the radius vector from the center of earth to the vehicle, positive clockwise from true north, deg.

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
INCLINATION	i	Orbit inclination angle: angle between the satellite orbit plane and the earth's equatorial plane measured counterclockwise from due east at the ascending node, ranging from zero degrees for a west-to-east orbit to 180 degrees for an east-to-west orbit, deg.
M SB Y M SB Z	M_y, M_z	Total aerodynamic moments about the normal to the vehicle pitch and yaw planes, respectively; M_y positive for pitch-up moment and M_z positive for nose left moment, ft-lb.
MACH NO.	M	Mach number.
MU	μ	Instantaneous vehicle longitude measured positive west and negative east from Greenwich, England, deg.
N SB Y/W N SB Z/W	N_y/W,N_z/W	Nondimensional aerodynamic forces normal to vehicle pitch and yaw planes, respectively; N_y positive left and N_z positive up.
P SB M Q SB M R SB M	P_m, Q_m, R_m	Attitude control program rates, angular velocities about vehicle axes X_m, Y_m, Z_m, respectively, deg/sec.
PHI SB I	ϕ_i	See "THETA SB I"
D-PHI SB I	$\dot{\phi}_i$	See "D-THETA SB I"
PHI SB L*	ϕ'_L	Vehicle instantaneous geocentric roll angle, deg.
PHI SB M	ϕ_m	See "THETA SB M"
D-THETA SB M	$\dot{\phi}_m$	See "D-THETA SB M"
PRESSURE	P_a	Atmospheric pressure, lb/ft^2
PSI SB I	ψ_i	See "THETA SB I"

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
D-PSI SB I	$\dot{\psi}_i$	See "D-THETA SB I"
PSI SB L*	ψ'_L	Vehicle centerline azimuth angle: angle between the local meridian and the projection of the vehicle centerline onto a plane perpendicular to the radius vector from the center of the earth to the vehicle, positive clockwise from true north, deg.
PSI SB M	ψ_m	See "THETA SB M"
D-PSI SB M	$\dot{\psi}_m$	See "D-THETA SB M"
Q	q	Dynamic pressure, lb/ft^2.
Q SB M	Q_m	See "P SB M"
R SB C	r_c	Instantaneous distance from the center of the earth to the vehicle, ft.
R SB L	r_L	Instantaneous earth radius, measured from the center of the earth to the point where the perpendicular from the vehicle to the earth's surface intersects the earth's surface, ft.
R SB M	R_m	See "P SB M"
RANGE	S	Surface range: instantaneous vehicle range along the earth's surface, based on the subtended arc and the mean earth radius from launch to present position, ft or n.mi.
RHO	ρ	Instantaneous vehicle geographic latitude: angle measured in the meridian plane between the equatorial plane and the line from the vehicle perpendicular to the earth's surface, positive north of the equator, deg.

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
RHO PRIME	ρ'	Instantaneous vehicle geocentric latitude: angle between the equatorial plane and the radius vector from the center of the earth to the vehicle, positive north of the equator, deg.
TAU SB P 1	τ_P	Radar polarization look angle: angle between the projection of the vehicle centerline on a plane perpendicular to the radar line of sight and the line of intersection of the plane containing the radar line of sight, perpendicular to the earth's surface at the radar site, positive counterclockwise from the apparent vertical (line of intersection) as viewed looking along the radar line of sight, deg.
TAU SB R 1	τ_R	Roll radar look angle: angle between the vehicle yaw plane and the projection of the radar line of sight onto the vehicle roll plane, measured clockwise from the pitch (positive Y_m) axis as viewed from the rear of the vehicle, deg.
TAU SB T 1	τ_T	Total radar look angle: angle between the vehicle centerline and the radar line of sight, measured from the rear of the vehicle, deg.
TEMPERATURE	T	Atmospheric temperature, degrees Rankine.
THETA SB I PSI SB I PHI SB I	θ_i, ψ_i ϕ_i	Euler angles specifying the orientation of the vehicle guidance inertial platform (i system) with respect to the inertial (eo) coordinate system which is

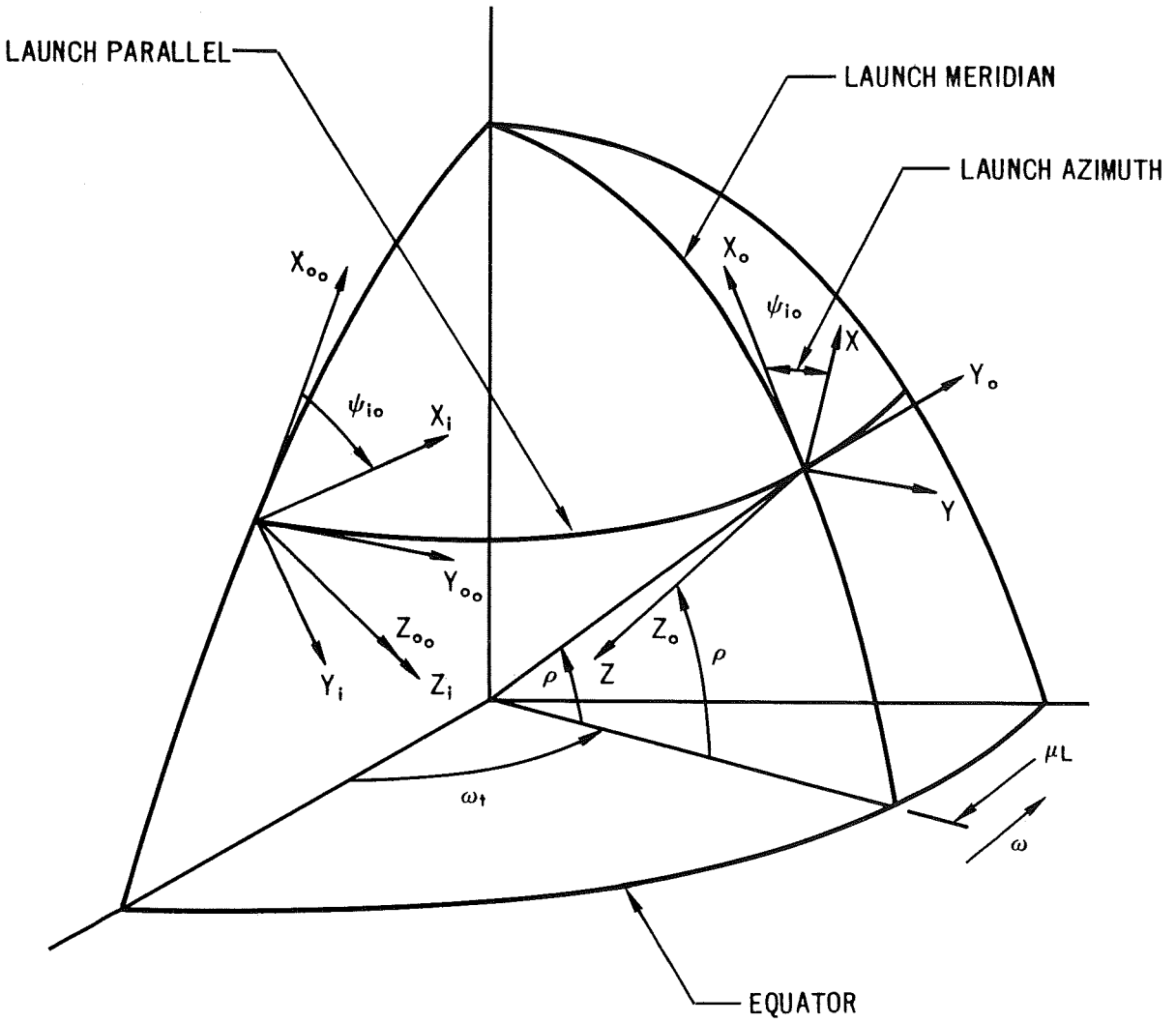
PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
THETA SB I (cont'd) PSI SB I PHI SB I		coincident with the rotating, earth-fixed (e) coordinate system at the time of launch. Order of rotation: ψ_i about Z (positive turning X_{eo} into Y_{eo}), θ_i about Y_{eo} (positive turning Z_{eo} into X_{eo}), ϕ_i about X_i (positive turning Y_{eo} into Z_{eo}), deg.
D-THETA SB I D-PSI SB I D-PHI SB I	$\dot{\theta}_i, \dot{\psi}_i, \dot{\phi}_i$	Rate change of Euler angles θ_i, ψ_i, and ϕ_i, deg/sec.
THETA SB L*	θ'_L	Vehicle centerline elevation angle: angle between the vehicle centerline and a plane perpendicular to the radius vector from the center of the earth to the vehicle, positive for vehicle nose pointing away from the earth, deg.
THETA SB M PSI SB M PHI SB M	θ_m, ψ_m, ϕ_m	Euler angles specifying the orientation of the vehicle axes (X_m, Y_m, Z_m) with respect to the inertial reference platform (i system). Order of rotation: pitch, θ_m about Y_m (positive turning Z_m into X_m); yaw, ψ_m about Z_m (positive turning X_m into Y_m); and roll, ϕ_m about X_m (positive turning Y_m into Z_m), deg.
D-THETA SB M D-PSI SB M D-PHI SB M	$\dot{\theta}_m, \dot{\psi}_m, \dot{\phi}_m$	Rate of change of Euler angles θ_m, ψ_m, and ϕ_m, deg/sec.
F SBT	F	Total vehicle thrust, lb.
TIME	t	Instantaneous time, measured from lift-off, sec.
TOT IMP VEL	V_{IMP}	Total impulsive velocity gain, ft/sec.

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
U	U	Earth parameter measured in the equatorial plane, distance from the center of the earth to a perpendicular to the equatorial plane passing through the intersection of the normal from the vehicle with the earth's surface, ft.
V SB E	V_e	Vehicle velocity measured relative to the launch point on a rotating earth (i.e., the origin of the X_{ee}, Y_{ee}, Z_{ee} or x, y, z coordinate systems), ft/sec.
D-V SB E	$\dot{V}_e$	Vehicle acceleration along the flight path, measured with respect to the launch point, ft/sec^2.
V SB I	V_I	Total velocity, measured with respect to a geocentric non-rotating, "inertial" reference system, ft/sec.
V I/V S	V_I/V_S	Ratio of vehicle instantaneous inertial velocity to circular satellite velocity at the instantaneous altitude.
VEL LOSS AA	$V_{AA\ LOSS}$	Velocity loss due to total angle of attack, ft/sec.
VEL LOSS CF	$V_{CF\ LOSS}$	Velocity loss due to aerodynamic chord force, ft/sec.
VEL LOSS G	$V_{G\ LOSS}$	Velocity loss due to gravity, ft/sec.
VEL LOSS NF	$V_{NF\ LOSS}$	Velocity loss due to normal force, ft/sec.
VEL LOSS VTA	$V_{TA\ LOSS}$	Velocity loss due to variation in thrust and altitude, ft/sec.
V (GAINED)	V_g	Integrating accelerometer velocity, ft/sec ($\int a_{x_m}\, dt$)

PRINTOUT SYMBOL	COMMON SYMBOL	DEFINITION
WEIGHT	W	Instantaneous vehicle weight, lb.
ESBW	ϵ_w	Wind azimuth angle: angle between the local (instantaneous) meridian and the direction from which the wind is blowing measured in a plane parallel to the local tangent plane, positive clockwise from true north, deg.
VSBW	V_w	Local wind speed, measured relative to a rotating earth, ft/sec.
X SB CG	X_{CG}	Instantaneous center of gravity measured positive aft of vehicle station zero, ft.
X SB EE Y SB EE Z SB EE	X_{ee}, Y_{ee}, Z_{ee}	Right-handed cartesian coordinate system with the origin located at mean sea level at the launch site and rotating with the earth: X_{ee} is positive north, Y_{ee} is positive east, and Z_{ee} is positive inward, ft.
D-X SB EE D-Y SB EE D-Z SB EE	$\dot{X}_{ee}$, $\dot{Y}_{ee}$, $\dot{Z}_{ee}$	Velocity components relative to the X_{ee}, Y_{ee}, Z_{ee} coordinate system, ft/sec.
X SB G Y SB G Z SB G	X, Y, Z	Right-handed cartesian coordinate system with the origin located at mean sea level at the launch site and rotating with the earth: X is positive in the direction of the intended flight (launch) azimuth, Y is positive to the right, and Z is positive inward perpendicular to the surface of the earth, ft.
D-X SB G D-Y SB G D-Z SB G	$\dot{X}$, $\dot{Y}$, $\dot{Z}$	Velocity components relative to the X, Y, Z coordinate system, ft/sec.
VSB WE	V_{we}	Total vehicle velocity with respect to the air, ft/sec.

COORDINATE DEFINITION

NOTE: THE Z AXES ARE PERPENDICULAR TO THE EARTH'S SURFACE AT THE LAUNCH SITE



GLIDE PHASE PRINTOUT

PRINTOUT SYMBOL	COMMON SYMBOL	ROW	DEFINITION
A* SBF	A'_f	GP 2	Azimuth angle from the launcher to the location of the impact or intercept point, deg.
BETA	β	GP 3	True anomaly at start of glide, deg.
BETA(F)	β_f	GP 2	True anomaly at impact or intercept altitude, deg.
DELTA	Δ	GP 3	Ratio of vehicle instantaneous inertial velocity to circular satellite velocity at the instantaneous altitude.
ECCENTRICITY	e	GP 3	Eccentricity of the instantaneous conic (2-D) trajectory.
E/M	E/M	GP 4	Energy per unit mass of the vehicle based on a zero potential energy at the surface of the earth at the launch point, ft^2/sec^2.
GAMMA SB 1F	γ_{1_f}	GP 1	Flight path elevation angle at impact on earth or intercept of a predetermined altitude, inertial (corresponding to S_f): angle between the total inertial velocity vector at impact, $\bar{V}_{I_f}$, and the plane at the surface of the earth perpendicular to the radius vector from the center of the earth to the point of impact, negative for vehicle heading toward the earth, deg.
GAMMA SB 2F	γ_{2_f}	GP 2	Flight path azimuth angle at impact on earth or intercept of a predetermined altitude, inertial (corresponding to S_f): angle between the impact point meridian and the projection of the total inertial velocity vector at impact, $\bar{V}_{I_f}$, onto the

PRINTOUT SYMBOL	COMMON SYMBOL	ROW	DEFINITION
GAMMA SB 2F Cont'd			plane at the surface of the earth perpendicular to the radius vector from the center of the earth to the point of impact, positive clockwise from true north, deg.
Inclination	i	GP 3	Orbit inclination angle: angle between the satellite orbit plane and the earth's equatorial plane measured counterclockwise from due east at the ascending node, ranging from zero degrees for a west-to-east orbit to 180 degrees for an east-to-west orbit, deg.
MU SBF	μ_f	GP 1	Longitude of vehicle impact on earth or intercept of a predetermined altitude (corresponding to S_f), deg.
Period	P	GP 4	Orbital period of the instantaneous conic (2-D) trajectory, min.
R(AP)	r_a	GP 4	Radial distance from the center of the earth to apogee of the instantaneous conic (2-D) trajectory.
R(PER)	r_p	GP 3	Radial distance from the center of the earth to perigee of the instantaneous conic (2-D) trajectory.
RHO SB F	ρ_f	GP 2	Geographic latitude of vehicle impact on earth or intercept of a predetermined altitude, deg.
RHO PRI (F)	ρ'_f	GP 1	Geocentric latitude of vehicle impact on earth or intercept of a predetermined altitude, deg.

PRINTOUT SYMBOL	COMMON SYMBOL	ROW	DEFINITION
S(BA R*)	$\bar{S}$	GP 2	Product of the average earth radius and the central angle (in radians) traversed during glide.
S SBF	S_f	GP 1	Predicted impact or intercept range, assuming vacuum trajectory, based on instantaneous position and velocity coordinates, n.mi.
TAU	τ	GP 4	Time since or to perigee at start of glide, sec.
TAU SBF	τ_f	GP 2	Time since or to perigee at the impact on earth or intercept of a predetermined altitude, sec.
T SB F	t_f	GP 1	Time to impact on earth or intercept of a predetermined altitude, measured from liftoff, sec.
V(AP)	V_a	GP 4	Apogee velocity (inertial) of the glide phase orbit, ft/sec.
V(F)	V_f	GP 1	Total velocity at impact on earth or intercept of a predetermined altitude (corresponding to S_f), assuming vacuum re-entry, measured with respect to a geocentric non-rotating "inertial" reference system, ft/sec.
V(INF)	V_{inf}	GP 4	Hyperbolic excess velocity, ft/sec.
V(PER)	V_p	GP 3	Perigee velocity (inertial) of the glide phase orbit, ft/sec.

TABLE I

SATURN V

NOMINAL WEIGHT ASSUMPTIONS

			WEIGHT (lb)
VEHICLE AT S-IC LIFTOFF			6,000,000
Propellants (Main Stage)		4,245,243	
Propellants (Center Engine Thrust Deacy)		4,017	
Frost		650	
VEHICLE AT S-IC CUTOFF			1,750,090
S-IC Stage at Separation		385,936	
Dry S-IC Stage	287,000		
Reserve & Residual Propellants & Service Items	58,603		
Outboard Engine Thrust Decay Prop.	13,333		
S-IC/S-II Interstage (Aft)		1,340	
S-II Ullage Rocket Propellants		3,050	
VEHICLE AT S-II IGNITION			1,386,764
Thrust Buildup Propellant		2,425	
S-IC/S-II Interstage (Forward)		9,450	
Launch Escape System		6,600	
Propellants (Main Stage)		912,939	
VEHICLE AT S-II CUTOFF			455,350

TABLE II

SATURN V

NOMINAL ENGINE PERFORMANCE ASSUMPTIONS

S-IC STAGE	
Thrust	7,500,000 lbs. (S.L.)
Specific Impulse	263.58 sec. (S.L.)
S-II STAGE	
Thrust	1,000,000 sec. (Vac.)
Specific Impulse	426 sec. (Vac.)
S-IVB STAGE	
Thrust	200,000 lbs (Vac.)
Specific Impulse	426 sec (Vac.)

TABLE III

SATURN V

UNCERTAINTIES OF VEHICLE PARAMETERS AFFECTING BOOST TRAJECTORY

PARAMETER ϕx	THREE SIGMA DEVIATION $3\sigma_x$	DEVIATION USED FOR MAXIMUM HEATING TRAJECTORY
S-IC STAGE		
Structure Weight (W_{s_1})	2%	+1.1%
Propellant Weight Loaded (W_{p_1})	0.25%	+0.138%
Thrust (F_1)	2%/Engine --- 0.894%	+0.492%
Specific Impulse (I_{SP_1})	1.5%/Engine --- 0.671%	+0.369%
Propellant Utilization Residual (PU_1)	13,000 lb	0.0
Aerodynamic Drag (D)	10.0%	5.5%
Autopilot Pitch Rate Error (Q_1)	1.0%	0.0
Autopilot Yaw Gyro Drift (G_{D_y})	0.25 deg/hr	0.0
Autopilot Pitch Gyro Drift (G_{D_p})	0.25 deg/hr	0.0
Autopilot Roll Gyro Drift (G_{D_r})	0.25 deg/hr	0.0
Thrust Misalignment - Yaw (Θ_{y_1})	0.5 deg/Eng --- 0.2236 deg	0.0
Thrust Misalignment - Pitch (Θ_{p_1})	0.5 deg/Eng --- 0.2236 deg	0.0
Center of Gravity	4 inches	0.0
S-II STAGE		
Structure Weight (W_{s_2})	2%	0.0
Propellant Weight Loaded (W_{p_2})	0.25%	0.0
Thrust (F_2)	3%/Engine --- 1.342%	0.0
Specific Impulse (I_{SP_2})	1%/Engine --- 0.447%	0.0
Propellant Utilization Residual (PU_2)	1390 lb	0.0
S-IVB STAGE		
Structure Weight (W_{s_3})	2%	0.0
Propellant Weight Loaded (W_{p_3})	0.25%	0.0

TABLE IV

SATURN V

NOMINAL TRAJECTORY SIMULATION

PRINT OUT KEY

```
AA63  BD  4 RR 75 CASE  1 ID1 100000000 ID2          0 ID3          0 PAGE    1

 1      TIME          ALTITUDE        F SB T         WEIGHT          RANGE
 2     V SB I          V SB E       V I / V S       X SB CG        A SB XB
 3   MACH NO.     CHORD FORCE     ALPHA SB P     ALPHA SB Y         ALPHA
 4   PRESSURE     TEMPERATURE     INCLINATION          Q          ALPHA * Q
 5 GAMMA(1I)PR. GAMMA(2I)PR.        P SB M         Q SB M          R SB M
 6 THETA SB L*   PSI SB L*         PSI SB M      THETA SB M       PHI SB M
 7  GAMMA SB 1   GAMMA SB 2        X SB EE        Y SB EE         Z SB EE
 8     V SB W       E SB W       D-X SB EE      D-Y SB EE       D-Z SB EE
 9     R SB C       R SB L            MU             RHO          RHO PRIME
10  N SB Y / W   N SB Z / W        D* SB 1        A* SB 1         E* SB 1
11     M SB Y       M SB Z        TAU SB T1      TAU SB R1       TAU SB P1
12 TOT IMP VEL                                                   V SB WE
13 VEL LOSS CF  VEL LOSS G   VEL LOSS VTA VEL LOSS NF  VEL LOSS AA

GP1     T SB F      S SB F     MU SB F   RHO PRI.(F)     V(F)    GAMMA SB 1F

GP2     BETA(F)   TAU SB F    S(BAR*)      A* SB F    RHO SB F  GAMMA SB 2F

GP3 ECCENTRICITY  R(PER)      V(PER)        BETA         DELTA    INCLINATION

GP4     PERIOD      R(AP)      V(AP)       V(INF)         TAU          E/M
```

NON'STAND. P

NON'STAND. T

NOMINAL TRAJECTORY

* S-IC LIFTOFF

1	0.0000	142.4	7499999.9	6000000.0	0.4
2	1342.7	0.1	0.05175	-97.982	40.218
3	0.000	0.0119	0.0000	-0.0000	0.0000
4	2113.11	533.65	28.28609	0.00	0.00
5	0.0043	90.0000	0.0000	0.0000	0.0000
6	89.8373	359.9999	0.0000	90.0000	0.0000
7	90.0000	180.0000	0.0	0.0	-143.0
8	0.00	70.00	0.00	0.00	-0.10
9	20910014.5	20909872.0	80.5653	28.4470	28.2861
10	-0.000	0.000	27364037.8	298.6129	-40.8750
11	0.000	-0.000	49.1622	65.6362	359.7881
12	0.0				0.10
13	0.00	0.00	0.00	0.00	0.00
1	10.0000	581.2	7517384.9	5715455.3	1.7
2	1345.6	91.0	0.05186	-98.066	42.263
3	0.080	9711.0389	-0.0776	-0.0265	0.0820
4	2080.76	532.34	28.28610	9.46	0.78
5	3.8782	89.9892	0.0000	0.0000	0.0000
6	89.8330	347.1394	0.0000	90.0000	0.0000
7	89.8813	269.2328	-0.0	-0.6	-581.5
8	0.00	70.00	-0.00	-0.19	-91.01
9	20910453.3	20909872.0	80.5653	28.4470	28.2861
10	-0.000	-0.000	27364325.0	298.6129	-40.8743
11	-1455.606	-497.399	49.1249	65.6537	359.7917
12	474.4				91.01
13	0.17	321.26	62.06	0.00	0.00
1	20.0000	2035.2	7573412.4	5430910.6	14.0
2	1362.7	203.9	0.05252	-98.346	44.655
3	0.181	35820.6147	-0.3772	-0.0482	0.3803
4	1976.49	528.01	28.28630	45.50	17.30
5	8.6029	89.8942	0.0000	-0.2277	0.0000
6	88.1835	64.4710	-0.0000	88.1780	-0.0000
7	88.6223	66.9896	5.0	8.9	-2036.2
8	0.00	70.00	1.92	4.51	-203.84
9	20911907.8	20909872.0	80.5652	28.4470	28.2861
10	-0.000	-0.000	27365269.5	298.6130	-40.8720
11	-33427.263	-4272.283	50.7502	66.2953	358.8262
12	973.0				203.90
13	1.57	642.47	125.19	0.00	0.01

NOMINAL TRAJECTORY

1	30.0000	4748.6	7671662.5	5146365.9	164.1
2	1412.4	345.1	0.05444	-98.738	47.790
3	0.309	27419.4758	-0.0136	-0.0623	0.0637
4	1793.65	519.92	28.28995	120.13	7.66
5	14.0921	89.5250	0.0000	-0.4970	0.0000
6	85.1384	67.8391	0.0000	85.0929	0.0000
7	85.2095	68.8654	59.6	147.1	-4749.6
8	0.00	70.00	10.39	26.89	-343.93
9	20914621.0	20909871.8	80.5648	28.4472	28.2863
10	-0.000	-0.000	27366943.0	298.6132	-40.8675
11	-2926.585	-13395.968	53.5449	67.2590	357.2898
12	1498.5				345.14
13	3.29	963.15	187.02	0.00	0.01
1	40.0000	9012.5	7810575.1	4861821.3	731.7
2	1519.4	522.0	0.05857	-99.304	51.337
3	0.473	53100.3584	0.1716	-0.0689	0.1849
4	1535.14	507.21	28.31665	241.10	44.57
5	19.7629	88.6446	0.0000	-0.6688	0.0000
6	79.9563	68.9437	-0.0000	79.8730	-0.0000
7	79.8408	69.4106	259.6	674.3	-9013.7
8	0.00	70.00	32.39	86.21	-513.83
9	20918884.5	20909871.3	80.5632	28.4477	28.2869
10	-0.000	0.001	27369345.8	298.6139	-40.8601
11	58632.781	-23532.395	58.3400	68.6044	354.9284
12	2053.9				522.01
13	5.81	1281.46	244.70	0.00	0.01
1	50.0000	15117.6	7979241.6	4577276.6	2210.5
2	1701.9	742.5	0.06562	-100.247	55.061
3	0.686	145934.6992	-0.0206	-0.0692	0.0722
4	1221.26	487.52	28.41833	403.70	29.13
5	24.6818	87.1652	0.0000	-0.7464	0.0000
6	73.1524	69.3966	0.0000	73.0298	0.0000
7	73.2285	69.6553	774.4	2055.7	-15118.5
8	0.00	70.00	74.52	200.94	-710.87
9	20924988.0	20909869.8	80.5589	28.4491	28.2883
10	-0.000	-0.000	27372327.5	298.6156	-40.8486
11	-6365.353	-21405.760	64.6951	69.9396	352.1812
12	2642.8				742.47
13	11.61	1593.48	295.29	0.00	0.02
1	60.0000	23273.9	8159683.9	4292731.9	5280.6
2	1965.7	1008.8	0.07580	-101.339	58.173
3	0.961	398120.4180	-0.1052	-0.0654	0.1239
4	885.47	458.32	28.66000	574.77	71.21
5	27.9201	85.2156	0.0000	-0.7464	0.0000
6	65.7322	69.6250	0.0000	65.5663	0.0000
7	65.8927	69.7991	1836.6	4932.5	-23273.4
8	0.00	70.00	142.41	386.89	-920.71
9	20933140.3	20909866.8	80.5499	28.4520	28.2913
10	-0.001	-0.001	27375555.8	298.6192	-40.8319
11	-3528.578	-2194.430	71.6787	70.9608	349.5028
12	3269.5				1008.80
13	30.62	1893.82	336.30	0.00	0.02

1	70.0000	33534.3	8328627.1	4008187.2	10732.6
2	2306.1	1326.9	0.08895	-102.794	62.477
3	1.325	545394.2500	-0.1566	-0.0598	0.1676
4	571.07	417.47	29.05677	704.05	118.01
5	29.3696	83.1054	0.0000	-0.7464	0.0000
6	58.3184	69.7678	0.0000	58.1027	0.0000
7	58.5300	69.8970	3715.8	10052.0	-33531.9
8	0.00	70.00	238.45	650.97	-1131.35
9	20943395.5	20909861.5	80.5340	28.4572	28.2965
10	-0.001	-0.002	27378521.0	298.6256	-40.8088
11	-48496.414	-18537.711	78.6921	71.6160	347.0416
12	3939.1				1326.86
13	68.91	2177.02	366.41	0.00	0.02

1	75.2379	39754.4	8405234.5	3859145.6	14831.1
2	2518.5	1522.2	0.09716	-103.720	65.705
3	1.566	524157.1055	-0.1223	-0.0563	0.1346
4	428.51	393.25	29.31621	738.08	99.33
5	29.5773	82.0119	0.0000	-0.6866	0.0000
6	54.6321	69.8253	0.0000	54.3870	0.0000
7	54.8093	69.9399	5125.9	13905.6	-39750.1
8	0.00	70.00	301.50	824.73	-1243.37
9	20949612.5	20909857.5	80.5221	28.4611	28.3004
10	-0.001	-0.002	27379770.8	298.6304	-40.7939
11	-120789.172	-55602.340	82.1880	71.8236	345.8691
12	4293.1				1522.19
13	91.09	2311.24	377.44	0.00	0.02

REMARKABLE TIME IS SPECIAL PRINT TIME
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* MAXIMUM DYNAMIC PRESSURE

1	75.2379	39754.4	8405234.5	3859145.6	14831.1
2	2518.5	1522.2	0.09716	-103.720	65.705
3	1.566	524157.1055	-0.1223	-0.0563	0.1346
4	428.51	393.25	29.31621	738.08	99.33
5	29.5773	82.0119	0.0000	-0.6866	0.0000
6	54.6321	69.8253	0.0000	54.3870	0.0000
7	54.8093	69.9399	5125.9	13905.6	-39750.1
8	0.00	70.00	301.50	824.73	-1243.37
9	20949612.5	20909857.5	80.5221	28.4611	28.3004
10	-0.001	-0.002	27379770.8	298.6304	-40.7939
11	-120789.172	-55602.340	82.1880	71.8236	345.8691
12	4293.1				1522.19
13	91.09	2311.24	377.44	0.00	0.02

1	80.0000	45926.8	8464965.6	3723642.5	19452.7
2	2734.2	1721.1	0.10549	-104.647	69.120
3	1.807	465440.9102	-0.1434	-0.0528	0.1528
4	317.35	377.39	29.57290	728.20	111.30
5	29.5298	81.0544	0.0000	-0.6270	0.0000
6	51.3918	69.8723	0.0000	51.1175	0.0000
7	51.5901	69.9758	6714.5	18254.8	-45918.6
8	0.00	70.00	367.06	1005.67	-1347.66
9	20955780.3	20909853.0	80.5086	28.4654	28.3048
10	-0.001	-0.002	27380627.3	298.6357	-40.7784
11	-198786.938	-73229.928	85.2641	71.9459	344.8561
12	4642.1				1721.13
13	111.14	2433.20	385.50	0.00	0.02
1	90.0000	60544.7	8554241.1	3439097.8	32451.8
2	3261.9	2213.1	0.12590	-106.989	77.261
3	2.345	295813.2109	-0.0531	-0.0461	0.0703
4	151.21	370.61	30.14113	584.17	41.06
5	28.8750	79.2168	0.0000	-0.5599	0.0000
6	45.3259	69.9585	-0.0000	44.9813	-0.0000
7	45.4337	70.0454	11178.2	30503.2	-60520.2
8	0.00	70.00	531.99	1461.62	-1574.27
9	20970385.3	20909840.8	80.4706	28.4776	28.3171
10	-0.000	-0.001	27381233.0	298.6508	-40.7391
11	-70768.730	-61466.174	91.0276	72.0301	342.9827
12	5418.3				2213.06
13	145.45	2672.27	396.38	0.01	0.02
1	100.0000	77492.1	8599940.9	3154553.1	50826.7
2	3895.6	2813.1	0.15042	-110.255	86.122
3	2.891	155931.6680	-0.0203	-0.0404	0.0452
4	66.17	394.06	30.69619	388.45	17.56
5	27.7187	77.6687	0.0000	-0.4931	0.0000
6	40.0788	70.0387	0.0000	39.6492	0.0000
7	40.1536	70.1128	17482.7	47845.9	-77431.1
8	0.00	70.00	735.41	2025.10	-1808.78
9	20987315.3	20909823.0	80.4169	28.4948	28.3343
10	-0.000	-0.000	27379643.0	298.6720	-40.6893
11	-15523.232	-30951.246	96.0156	71.9523	341.3621
12	6261.5				2813.10
13	166.83	2888.72	401.78	0.01	0.02
1	110.0000	96846.4	8620937.1	2870008.4	75710.1
2	4638.3	3526.2	0.17918	-114.731	95.795
3	3.545	75816.9385	-0.0291	-0.0349	0.0455
4	27.10	411.69	31.19677	239.23	10.87
5	26.3017	76.4187	0.0000	-0.4312	0.0000
6	35.6219	70.1193	-0.0000	35.0894	-0.0000
7	35.7053	70.1844	26017.4	71372.9	-96709.6
8	0.00	70.00	978.18	2699.02	-2047.60
9	21006645.3	20909799.3	80.3441	28.5180	28.3576
10	-0.000	-0.000	27375114.5	298.7007	-40.6276
11	-8705.940	-10456.407	100.2534	71.7739	339.9660
12	7184.6				3526.22
13	178.73	3084.22	404.30	0.01	0.02

1	120.0000	118680.0	8629844.9	2585463.8	108268.6
2	5498.8	4361.6	0.21253	-120.093	106.956
3	4.211	35027.2158	-0.0621	-0.0290	0.0685
4	10.52	446.41	31.62923	131.03	8.98
5	24.8097	75.4307	0.0000	-0.3270	0.0000
6	31.8771	70.2048	0.0000	31.2208	0.0000
7	31.9933	70.2644	37184.2	102214.9	-118399.7
8	0.00	70.00	1262.37	3489.66	-2291.69
9	21028448.0	20909768.3	80.2487	28.5483	28.3879
10	-0.000	-0.000	27366872.3	298.7381	-40.5523
11	-7264.762	-3395.334	103.8154	71.5399	338.7663
12	8204.1				4361.55
13	184.96	3261.04	405.40	0.01	0.02

1	130.0000	143117.7	8633356.5	2300919.1	149758.1
2	6493.9	5335.9	0.25114	-127.091	120.503
3	4.926	15628.4100	0.0128	-0.0225	0.0259
4	3.98	488.17	31.99607	67.92	1.76
5	23.3691	74.6567	0.0000	-0.2658	0.0000
6	28.8776	70.2979	-0.0000	28.0729	-0.0000
7	28.9186	70.3556	51417.4	141597.9	-142579.4
8	0.00	70.00	1592.47	4410.13	-2546.79
9	21052846.0	20909729.0	80.1271	28.5867	28.4264
10	-0.000	0.000	27354106.0	298.7857	-40.4616
11	391.712	-688.183	106.6724	71.2930	337.7799
12	9342.6				5335.85
13	188.10	3421.61	405.87	0.01	0.02

1959 ARDC P

1959 ARDC T

1	140.0000	170389.9	8634713.9	2016374.4	201603.0
2	7651.2	6476.3	0.29609	-136.453	137.666
3	5.857	7045.3265	0.0405	-0.0154	0.0433
4	1.46	508.79	32.30607	35.13	1.52
5	22.0721	74.0535	0.0000	-0.2658	0.0000
6	26.3964	70.4026	-0.0000	25.4150	-0.0000
7	26.4095	70.4606	69211.7	190921.3	-169412.9
8	0.00	70.00	1976.27	5482.56	-2824.59
9	21080069.3	20909680.0	79.9749	28.6345	28.4742
10	-0.000	0.000	27335948.3	298.8452	-40.3533
11	18.366	-6.985	109.0419	71.0439	336.9409
12	10631.5				6476.30
13	189.69	3568.34	406.07	0.01	0.02

1	146.6040	190133.0	8635121.5	1828461.1	242338.2	
2	8524.7	7340.4	0.33004	-144.836	151.873	
3	6.886	4126.9983	-0.0390	-0.0105	0.0404	
4	0.70	472.91	32.48487	23.29	0.94	
5	21.2961	73.7309	0.0000	-0.2148	0.0000	
6	24.9083	70.4803	-0.0000	23.7924	-0.0000	
7	25.0008	70.5388	83201.1	229753.3	-188719.6	
8	0.00	70.00	2265.70	6292.64	-3025.11	
9	21099774.0	20909641.8	79.8553	28.6719	28.5116	
10	-0.000	-0.000	27320528.5	298.8919	-40.2707	
11	382.365	102.902	110.4670	70.8723	336.4251	
12	11586.7				7340.44	
13	190.29	3658.74	406.14	0.01	0.02	

* CENTER ENGINE SHUTDOWN

1	146.6040	190133.0	6908095.5	1828461.1	242338.2	
2	8524.7	7340.4	0.33004	-144.836	121.484	
3	6.886	4126.9983	-0.0390	-0.0105	0.0404	
4	0.70	472.91	32.48487	23.29	0.94	
5	21.2961	73.7309	0.0000	-0.2148	0.0000	
6	24.9083	70.4803	-0.0000	23.7924	-0.0000	
7	25.0008	70.5388	83201.1	229753.3	-188719.6	
8	0.00	70.00	2265.70	6292.64	-3025.11	
9	21099774.0	20909641.8	79.8553	28.6719	28.5116	
10	-0.000	-0.000	27320528.5	298.8919	-40.2707	
11	382.365	102.902	110.4670	70.8723	336.4251	
12	11586.7				7340.44	
13	190.29	3658.74	406.14	0.01	0.02	
1	150.0000	200800.8	6908199.9	1751156.0	265362.7	
2	8906.3	7717.3	0.34490	-149.704	126.869	
3	7.446	3046.6841	-0.0375	-0.0081	0.0383	
4	0.46	447.06	32.55314	17.77	0.68	
5	20.8826	73.6214	0.0000	-0.2148	0.0000	
6	24.2536	70.5226	-0.0000	23.0629	-0.0000	
7	24.3444	70.5818	91111.8	251730.3	-199105.5	
8	0.00	70.00	2394.15	6653.20	-3091.90	
9	21110420.5	20909620.3	79.7876	28.6930	28.5327	
10	-0.000	-0.000	27311472.8	298.9183	-40.2248	
11	424.966	91.564	111.0964	70.7911	336.1946	
12	12008.5				7717.31	
13	190.51	3703.44	406.15	0.01	0.03	
GP1	428.4362	360.017	74.02495	30.11668	9603.453	-28.970141
GP2	-176.28979	-830.4337	374.867	70.64381	30.28400	77.01692
GP3	0.8970319	190.185	152014.781	177.46867	0.3449031	32.55314
GP4	33.18388	3503.869	8251.139		882.1630	46677384.

1	150.6040	202727.4	6908214.9	1737406.8	269591.3	
2	8976.2	7786.4	0.34763	-150.594	127.876	
3	7.552	2875.9179	-0.0407	-0.0076	0.0414	
4	0.42	442.40	32.56499	16.88	0.70	
5	20.8110	73.6028	0.0000	-0.2148	0.0000	
6	24.1376	70.5304	0.0000	22.9331	0.0000	
7	24.2316	70.5896	92565.0	255768.8	-200976.7	
8	0.00	70.00	2417.66	6719.21	-3104.08	
9	21112342.5	20909616.0	79.7751	28.6968	28.5366	
10	-0.000	-0.000	27309786.0	298.9232	-40.2165	
11	465.234	87.335	111.2080	70.7763	336.1535	
12	12085.5				7786.42	
13	190.54	3711.26	406.15	0.01	0.03	
GP1	430.8573	365.854	73.91681	30.14312	9674.690	-28.866846
GP2	-176.23577	-831.0227	380.386	70.64940	30.31053	77.05070
GP3	0.8953100	193.577	150608.615	177.43079	0.3476261	32.56499
GP4	33.23838	3504.521	8319.069		883.0270	47363147.

* OUTBOARD ENGINE SHUTDOWN - S-IC/S-II STAGING

1	150.6040	202727.4	0.0	1389814.0	269591.3	
2	8976.2	7786.4	0.34763	-173.085	-0.067	
3	7.552	2875.9179	-0.0407	-0.0076	0.0414	
4	0.42	442.40	32.56499	16.88	0.70	
5	20.8110	73.6028	0.0000	-0.2148	0.0000	
6	24.1376	70.5304	0.0000	22.9331	0.0000	
7	24.2316	70.5896	92565.0	255768.8	-200976.7	
8	0.00	70.00	2417.66	6719.21	-3104.08	
9	21112342.5	20909616.0	79.7751	28.6968	28.5366	
10	-0.000	-0.000	27309786.0	298.9232	-40.2165	
11	1211.040	227.341	111.2080	70.7763	336.1535	
12	12085.5				7786.42	
13	190.54	3711.26	406.15	0.01	0.03	
GP1	430.8573	365.854	73.91681	30.14312	9674.690	-28.866846
GP2	-176.23577	-831.0227	380.386	70.64940	30.31053	77.05070
GP3	0.8953100	193.577	150608.615	177.43079	0.3476261	32.56499
GP4	33.23838	3504.521	8319.069		883.0270	47363147.

1	154.4040	214665.9	0.0	1389814.0	296306.3	
2	8934.0	7737.8	0.34609	-173.085	-0.041	
3	7.762	1792.6322	-0.0624	-0.0054	0.0626	
4	0.25	413.50	32.56447	10.68	0.67	
5	20.1783	73.6491	0.0000	-0.2148	0.0000	
6	23.4076	70.5792	0.0000	22.1168	0.0000	
7	23.5232	70.6386	101747.5	281297.0	-212550.9	
8	0.00	70.00	2415.27	6716.67	-2987.62	
9	21124256.8	20909591.0	79.6966	28.7212	28.5609	
10	-0.000	-0.000	27298972.5	298.9538	-40.1638	
11	1166.871	100.154	111.9104	70.6808	335.8934	
12	12085.5				7737.77	
13	190.74	3759.71	406.15	0.01	0.03	
GP1	430.8459	365.831	73.91720	30.14290	9674.443	-28.867029
GP2	-176.23598	-831.0218	375.167	70.65045	30.31031	77.05160
GP3	0.8953156	193.566	150613.180	177.51748	0.3460871	32.56447
GP4	33.23819	3504.518	8318.849		886.8279	47360762.

* S-II LIFTOFF

1	154.4040	214665.9	999958.9	1384339.0	296306.3	
2	8934.0	7737.8	0.34609	-173.439	23.199	
3	7.762	1792.6322	-0.0624	-0.0054	0.0626	
4	0.25	413.50	32.56447	10.68	0.67	
5	20.1783	73.6491	0.0000	17.0659	0.0000	
6	23.4076	70.5792	0.0000	22.1168	0.0000	
7	23.5232	70.6386	101747.5	281297.0	-212550.9	
8	0.00	70.00	2415.27	6716.67	-2987.62	
9	21124256.8	20909591.0	79.6966	28.7212	28.5609	
10	-0.000	-0.000	27298972.5	298.9538	-40.1638	
11	1178.224	101.128	111.9104	70.6808	335.8934	
12	12085.5				7737.77	
13	190.74	3759.71	406.15	0.01	0.03	
GP1	430.8459	365.831	73.91720	30.14290	9674.443	-28.867029
GP2	-176.23598	-831.0218	375.167	70.65045	30.31031	77.05160
GP3	0.8953156	193.566	150613.180	177.51748	0.3460871	32.56447
GP4	33.23819	3504.518	8318.849		886.8279	47360762.

F001 GIMBAL STATION EQUAL ZERO, L SET EQUAL 0

1	160.0000	231703.6	999981.4	1371202.9	335887.0	
2	9001.1	7797.4	0.34883	0.000	23.464	
3	8.243	0.0000	10.7235	-0.0019	10.7235	
4	0.11	372.33	32.58237	5.43	58.24	
5	19.4356	73.6770	0.0000	-0.0789	0.0000	
6	33.3120	70.5664	-0.0000	31.8936	-0.0000	
7	22.6417	70.7109	115358.6	319165.2	-228982.2	
8	0.00	70.00	2449.20	6817.06	-2885.95	
9	21141256.5	20909554.0	79.5801	28.7572	28.5969	
10	0.000	0.000	27282492.0	298.9991	-40.0868	
11	0.000	0.000	102.5532	71.6740	339.2341	
12	12216.2				7797.41	
13	190.77	3828.69	406.16	0.01	2.05	
GP1	435.8745	376.329	73.72249	30.19004	9791.542	-28.769759
GP2	-176.14079	-831.6507	379.029	70.66188	30.35760	77.12122
GP3	0.8926079	198.934	148460.994	177.54836	0.3488292	32.58237
GP4	33.32898	3505.881	8424.112		892.2134	48498870.

1	170.0000	260964.2	999996.2	1347728.7	407947.9	
2	9128.8	7912.6	0.35402	0.000	23.873	
3	9.292	0.0000	11.6886	0.0047	11.6886	
4	0.02	301.76	32.61364	1.40	16.36	
5	18.1538	73.7303	0.0000	-0.0789	0.0000	
6	32.7551	70.6870	-0.0000	31.1046	-0.0000	
7	21.1194	70.8426	140155.7	388240.4	-256945.0	
8	0.00	70.00	2510.41	6998.67	-2706.71	
9	21170450.8	20909487.0	79.3677	28.8224	28.6622	
10	0.000	0.000	27251242.3	299.0817	-39.9493	
11	0.000	0.000	103.1215	71.6329	339.0514	
12	12452.9				7912.64	
13	190.77	3945.61	406.16	0.01	6.56	
GP1	444.8854	395.420	73.36792	30.27490	10001.538	-28.574876
GP2	-175.96817	-832.9781	386.047	70.68220	30.44275	77.25073
GP3	0.8876120	208.882	144691.436	177.60412	0.3540203	32.61364
GP4	33.49559	3508.269	8614.894		901.8717	50574209.

1	174.4040	273376.0	999998.2	1337390.7	440235.5
2	9188.2	7966.9	0.35643	0.000	24.057
3	9.412	0.0000	12.0995	0.0076	12.0995
4	0.01	298.19	32.62717	0.67	8.13
5	17.6027	73.7552	0.0000	-0.0789	0.0000
6	32.5114	70.7411	-0.0000	30.7572	-0.0000
7	20.4647	70.9017	151271.7	419241.2	-268692.0
8	0.00	70.00	2537.75	7079.96	-2627.98
9	21182832.5	20909457.0	79.2725	28.8515	28.6912
10	0.000	0.000	27236743.3	299.1187	-39.8887
11	0.000	0.000	103.3715	71.6137	338.9710
12	12558.4				7966.95
13	190.77	3994.57	406.16	0.01	8.83
GP1	448.8236	403.937	73.20951	30.31240	10094.518 -28.477339
GP2	-175.89125	-833.6659	389.150	70.69109	30.48037 77.30943
GP3	0.8853344	213.434	143053.545	177.62936	0.3564294 32.62717
GP4	33.57094	3509.290	8700.486		906.1709 51507192.

* LES AND S-IC/S-II INTERSTAGE (FWD) JETTISON

1	174.4040	273376.0	999998.2	1321340.7	440235.5
2	9188.2	7966.9	0.35643	0.000	24.350
3	9.412	0.0000	12.0995	0.0076	12.0995
4	0.01	298.19	32.62717	0.67	8.13
5	17.6027	73.7552	0.0000	-0.0789	0.0000
6	32.5114	70.7411	-0.0000	30.7572	-0.0000
7	20.4647	70.9017	151271.7	419241.2	-268692.0
8	0.00	70.00	2537.75	7079.96	-2627.98
9	21182832.5	20909457.0	79.2725	28.8515	28.6912
10	0.000	0.000	27236743.3	299.1187	-39.8887
11	0.000	0.000	103.3715	71.6137	338.9710
12	12558.4				7966.95
13	190.77	3994.57	406.16	0.01	8.83
GP1	448.8236	403.937	73.20951	30.31240	10094.518 -28.477339
GP2	-175.89125	-833.6659	389.150	70.69109	30.48037 77.30943
GP3	0.8853344	213.434	143053.545	177.62936	0.3564294 32.62717
GP4	33.57094	3509.290	8700.486		906.1709 51507192.

1	180.0000	288734.4	999999.3	1308204.5	481762.6
2	9268.1	8040.7	0.35966	0.000	24.594
3	9.499	0.0000	12.6059	0.0114	12.6059
4	0.00	298.19	32.64437	0.27	3.37
5	16.9172	73.7875	0.0000	-0.0789	0.0000
6	32.2030	70.8107	0.0000	30.3157	0.0000
7	19.6498	70.9777	165572.2	459156.1	-283120.9
8	0.00	70.00	2573.32	7185.77	-2528.94
9	21198152.5	20909418.5	79.1499	28.8888	28.7285
10	0.000	0.000	27217664.8	299.1662	-39.8116
11	0.000	0.000	103.6890	71.5882	338.8687
12	12695.3				8040.69
13	190.77	4054.59	406.16	0.01	12.00
GP1	453.8648	414.995	73.00366	30.36076	10214.612 -28.342059
GP2	-175.79144	-834.6429	393.255	70.70246	30.52889 77.38645
GP3	0.8823331	219.450	140966.809	177.66083	0.3596600 32.64437
GP4	33.66973	3510.573	8812.002		911.6759 52725037.

1	190.0000	315052.8	999999.9	1284730.3	557402.3	
2	9418.8	8181.1	0.36573	0.000	25.043	
3	9.169	0.0000	13.4726	0.0183	13.4726	
4	0.00	331.30	32.67449	0.05	0.71	
5	15.7274	73.8486	0.0000	-0.0789	0.0000	
6	31.6560	70.9378	0.0000	29.5267	0.0000	
7	18.2358	71.1162	191627.1	531972.6	-307527.2	
8	0.00	70.00	2637.87	7378.28	-2352.40	
9	21224400.3	20909348.8	78.9263	28.9563	28.7960	
10	0.000	0.000	27181730.3	299.2528	-39.6737	
11	0.000	0.000	104.2555	71.5397	338.6860	
12	12943.5				8181.14	
13	190.77	4155.90	406.16	0.01	18.41	
GP1	462.8164	435.062	72.62955	30.44757	10430.846	-28.074657
GP2	-175.61045	-836.6507	400.648	70.72267	30.61598	77.52862
GP3	0.8767616	230.669	137292.418	177.71870	0.3657337	32.67449
GP4	33.85181	3512.790	9015.366		921.6412	54954190.

1	200.0000	339946.7	1000000.0	1261256.2	634924.5	
2	9579.5	8332.6	0.37219	0.000	25.510	
3	8.671	0.0000	14.2818	0.0254	14.2818	
4	0.00	384.26	32.70385	0.01	0.19	
5	14.5833	73.9142	0.0000	-0.0823	0.0000	
6	31.1072	71.0684	-0.0000	28.7309	-0.0000	
7	16.8776	71.2582	218334.0	606736.7	-330170.6	
8	0.00	70.00	2703.74	7575.31	-2176.34	
9	21249223.3	20909277.8	78.6969	29.0250	28.8647	
10	0.000	0.000	27143412.0	299.3416	-39.5354	
11	0.000	0.000	104.8274	71.4869	338.5008	
12	13196.3				8332.59	
13	190.77	4249.81	406.16	0.01	25.80	
GP1	471.7057	455.541	72.24701	30.53489	10649.448	-27.776671
GP2	-175.42582	-838.9991	408.130	70.74279	30.70359	77.67682
GP3	0.8709108	242.522	133686.547	177.77873	0.3721904	32.70385
GP4	34.04149	3514.908	9224.109		931.7846	57255294.

1	200.0000	339946.7	1000000.0	1261256.2	634924.5	
2	9579.5	8332.6	0.37219	0.000	25.510	
3	8.671	0.0000	14.2818	0.0254	14.2818	
4	0.00	384.26	32.70385	0.01	0.19	
5	14.5833	73.9142	0.0000	-0.0823	0.0000	
6	31.1072	71.0684	-0.0000	28.7309	-0.0000	
7	16.8776	71.2582	218334.0	606736.7	-330170.6	
8	0.00	0.00	2703.74	7575.31	-2176.34	
9	21249223.3	20909277.8	78.6969	29.0250	28.8647	
10	0.000	0.000	27143412.0	299.3416	-39.5354	
11	0.000	0.000	104.8274	71.4869	338.5008	
12	13196.3				8332.59	
13	190.77	4249.81	406.16	0.01	25.80	
GP1	471.7057	455.541	72.24701	30.53489	10649.448	-27.776671
GP2	-175.42582	-838.9991	408.130	70.74279	30.70359	77.67682
GP3	0.8709108	242.522	133686.547	177.77873	0.3721904	32.70385
GP4	34.04149	3514.908	9224.109		931.7846	57255294.

TABLE V

SATURN V

MAXIMUM HEATING TRAJECTORY SIMULATION

PRINT OUT KEY

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AA63  BD  4 RR 75 CASE  2 ID1 100000000 ID2          0 ID3          0 PAGE    1

 1      TIME          ALTITUDE        F SB T         WEIGHT          RANGE
 2     V SB I          V SB E       V I / V S       X SB CG        A SB XB
 3   MACH NO.      CHORD FORCE     ALPHA SB P     ALPHA SB Y        ALPHA
 4   PRESSURE      TEMPERATURE     INCLINATION          Q         ALPHA * Q
 5 GAMMA(1I)PR   GAMMA(2I)PR.       P SB M         Q SB M          R SB M
 6 THETA SB L*    PSI SB L*        PSI SB M      THETA SB M       PHI SB M
 7  GAMMA SB 1   GAMMA SB 2        X SB EE        Y SB EE         Z SB EE
 8     V SB W        E SB W       D-X SB EE      D-Y SB EE       D-Z SB EE
 9     R SB C        R SB L           MU             RHO          RHO PRIME
10  N SB Y / W    N SB Z / W       D* SB 1        A* SB 1         E* SB 1
11     M SB Y        M SB Z        TAU SB T1      TAU SB R1       TAU SB P1
12 TOT IMP VEL                                                   V SB WE
13 VEL LOSS CF  VEL LOSS G    VEL LOSS VTA VEL LOSS NF  VEL LOSS AA

GP1     T SB F      S SB F     MU SB F    RHO PRI.(F)     V(F)    GAMMA SB 1F

GP2     BETA(F)   TAU SB F    S(BAR*)      A* SB F    RHO SB F   GAMMA SB 2F

GP3 ECCENTRICITY  R(PER)      V(PER)         BETA         DELTA    INCLINATION

GP4     PERIOD      R(AP)      V(AP)        V(INF)         TAU         E/M
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AA63 BD 4 RR 75 CASE 2 ID1 100000000 ID2 0 ID3 0 PAGE 2

* S-IC LIFTOFF

1	0.0000	142.4	7436223.1	6015606.0	0.4
2	1342.7	0.1	0.05175	-97.977	39.770
3	0.016	439.2751	89.6911	-0.0002	89.6911
4	2152.78	533.59	28.28609	0.41	36.40
5	0.0043	90.0000	0.0000	0.0000	0.0000
6	89.8373	359.9999	0.0000	90.0000	0.0000
7	90.0000	180.0000	0.0	0.0	-143.0
8	18.55	70.00	0.00	0.00	-0.10
9	20910014.5	20909872.0	80.5653	28.4470	28.2861
10	-0.000	0.000	27364037.8	298.6129	-40.8750
11	76766.389	-0.205	49.1622	65.6362	359.7881
12	0.0				18.55
13	0.00	0.00	0.00	0.00	0.00
1	10.0000	558.1	7452412.0	5733501.4	2.1
2	1345.0	86.3	0.05184	-98.061	41.764
3	0.078	9876.7019	12.7925	-0.0322	12.7926
4	2122.65	532.40	28.28609	9.12	116.73
5	3.6786	89.9945	0.0000	0.0000	0.0000
6	89.8332	347.1405	0.0000	90.0000	0.0000
7	89.6682	256.9661	-0.4	-1.8	-558.3
8	20.04	70.00	-0.11	-0.49	-86.30
9	20910430.0	20909872.0	80.5653	28.4470	28.2861
10	-0.000	0.001	27364310.8	298.6129	-40.8743
11	244253.883	-614.837	49.1249	65.6537	359.7917
12	470.7				88.48
13	0.18	321.26	50.23	0.10	82.69
1	20.0000	1939.4	7504595.6	5451396.9	7.4
2	1359.9	193.8	0.05241	-98.323	44.066
3	0.174	38220.1797	6.5949	-0.0549	6.5951
4	2025.54	528.43	28.28622	42.98	283.47
5	8.1921	89.9164	0.0000	-0.2277	0.0000
6	88.1834	64.4711	-0.0000	88.1780	-0.0000
7	88.9744	65.8445	1.9	0.5	-1939.8
8	24.97	70.00	1.42	3.17	-193.78
9	20911811.3	20909872.0	80.5653	28.4470	28.2861
10	-0.000	0.004	27365212.5	298.6129	-40.8722
11	583326.141	-4851.903	50.7504	66.2953	358.8262
12	965.2				195.85
13	1.58	642.48	113.75	0.21	87.95
1	30.0000	4520.6	7595795.7	5169292.4	128.6
2	1404.7	328.5	0.05414	-98.705	47.102
3	0.297	28050.7573	5.3711	-0.0697	5.3716
4	1855.82	521.03	28.28902	115.33	619.48
5	13.4845	89.5868	0.0000	-0.4970	0.0000
6	85.1383	67.8390	0.0000	85.0929	0.0000
7	85.7066	68.7026	47.4	113.8	-4521.6
8	34.20	70.00	8.93	22.91	-327.57
9	20914393.3	20909871.8	80.5649	28.4471	28.2863
10	-0.000	0.008	27366818.0	298.6131	-40.8679
11	1186921.500	-15406.632	53.5453	67.2590	357.2898
12	1485.9				332.80
13	3.46	963.28	176.77	0.40	90.48

1	40.0000	8588.0	7736418.8	4887187.9	627.7
2	1502.7	497.7	0.05793	-99.250	50.572
3	0.459	54580.0664	4.9315	-0.0767	4.9321
4	1594.13	509.35	28.31099	236.10	1164.47
5	19.0621	88.7774	0.0000	-0.6688	0.0000
6	79.9560	68.9436	-0.0000	79.8730	-0.0000
7	80.5111	69.3554	223.8	576.9	-8588.9
8	48.74	70.00	28.93	76.79	-490.87
9	20918460.0	20909871.3	80.5635	28.4476	28.2868
10	-0.000	0.017	27369139.0	298.6137	-40.8609
11	1780085.813	-27680.836	58.3408	68.6045	354.9283
12	2035.9				507.99
13	6.02	1282.00	236.06	0.74	92.36
1	50.0000	14432.9	7907552.1	4605083.4	1959.5
2	1672.5	709.2	0.06448	-100.148	54.208
3	0.674	148766.7637	4.3450	-0.0771	4.3457
4	1275.66	490.27	28.39812	406.83	1767.96
5	24.0630	87.3925	0.0000	-0.7464	0.0000
6	73.1517	69.3962	0.0000	73.0298	0.0000
7	74.1170	69.6294	688.2	1820.5	-14433.9
8	69.64	70.00	67.59	182.01	-682.11
9	20924303.5	20909870.0	80.5596	28.4489	28.2881
10	-0.001	0.030	27372052.0	298.6153	-40.8500
11	1508125.250	-26760.449	64.6965	69.9396	352.1810
12	2618.6				731.34
13	11.88	1595.03	288.23	1.33	94.07
1	60.0000	22277.7	8091388.0	4322978.8	4755.3
2	1919.6	963.9	0.07402	-101.221	56.992
3	0.955	433787.7500	3.8924	-0.0737	3.8931
4	933.55	462.02	28.61211	597.89	2327.67
5	27.5233	85.5355	0.0000	-0.7464	0.0000
6	65.7308	69.6243	0.0000	65.5663	0.0000
7	67.0220	69.7854	1656.0	4439.4	-22277.5
8	97.68	70.00	130.13	353.29	-887.35
9	20932144.8	20909867.3	80.5515	28.4515	28.2908
10	-0.001	0.046	27375265.5	298.6186	-40.8341
11	221532.750	-4193.520	71.6809	70.9609	349.5024
12	3238.2				1006.08
13	31.82	1897.32	330.80	2.19	95.54
1	70.0000	32179.9	8260094.7	4040874.3	9746.5
2	2238.5	1264.4	0.08634	-102.616	60.780
3	1.327	626502.6250	3.4687	-0.0690	3.4694
4	619.59	421.72	28.97412	766.85	2660.48
5	29.2164	83.4912	0.0000	-0.7464	0.0000
6	58.3157	69.7664	0.0000	58.1027	0.0000
7	59.8423	69.8899	3376.8	9125.0	-32177.8
8	133.08	70.00	218.72	596.91	-1092.95
9	20942042.0	20909862.5	80.5369	28.4563	28.2956
10	-0.001	0.052	27378313.8	298.6245	-40.8122
11	1305981.000	-25961.055	78.6956	71.6160	347.0408
12	3899.5				1336.21
13	74.49	2183.71	362.70	3.25	96.85

1	76.9604	40295.3	8363590.0	3844518.3	14953.6
2	2509.9	1514.2	0.09683	-103.820	65.070
3	1.647	588167.6094	2.5419	-0.0630	2.5427
4	426.99	390.44	29.30489	814.12	2070.07
5	29.5740	82.0578	0.0000	-0.6866	0.0000
6	53.4558	69.8406	-0.0000	53.2044	-0.0000
7	54.9497	69.9490	5168.0	14020.8	-40290.9
8	135.33	70.00	298.75	817.62	-1239.00
9	20950153.0	20909857.5	80.5217	28.4612	28.3005
10	-0.001	0.038	27380040.5	298.6305	-40.7929
11	3431089.125	-85012.180	83.3052	71.8744	345.4999
12	4383.2				1595.79
13	109.13	2369.70	378.41	3.78	97.49

REMARKABLE TIME IS SPECIAL PRINT TIME
DERIV Q PRESSURE EQUALS .16523182-01
* MAXIMUM DYNAMIC PRESSURE

1	76.9604	40295.3	8363590.0	3844518.3	14953.6
2	2509.9	1514.2	0.09683	-103.820	65.070
3	1.647	588167.6094	2.5419	-0.0630	2.5427
4	426.99	390.44	29.30489	814.12	2070.07
5	29.5740	82.0578	0.0000	-0.6866	0.0000
6	53.4558	69.8406	-0.0000	53.2044	-0.0000
7	54.9497	69.9490	5168.0	14020.8	-40290.9
8	135.33	70.00	298.75	817.62	-1239.00
9	20950153.0	20909857.5	80.5217	28.4612	28.3005
10	-0.001	0.038	27380040.5	298.6305	-40.7929
11	3431089.125	-85012.180	83.3052	71.8744	345.4999
12	4383.2				1595.79
13	109.13	2369.70	378.41	3.78	97.49

1	80.0000	44162.7	8402545.1	3758769.8	17772.2
2	2643.2	1636.7	0.10198	-104.407	67.239
3	1.804	547185.9141	2.1641	-0.0603	2.1649
4	354.50	379.23	29.46513	810.14	1753.90
5	29.5603	81.4453	0.0000	-0.6270	0.0000
6	51.3872	69.8700	-0.0000	51.1175	-0.0000
7	52.8707	69.9727	6136.6	16673.1	-44155.8
8	135.33	70.00	339.13	929.11	-1304.09
9	20954017.5	20909854.8	80.5135	28.4638	28.3032
10	-0.001	0.032	27380630.3	298.6338	-40.7833
11	3539708.125	-98662.797	85.2692	71.9461	344.8548
12	4604.2				1721.81
13	123.74	2448.29	383.80	3.92	97.68

1	90.0000	58302.7	8496537.8	3476665.3	29858.0
2	3149.3	2105.0	0.12155	-106.665	75.264
3	2.298	363632.6133	0.5090	-0.0482	0.5113
4	179.58	367.62	30.03041	666.26	340.65
5	28.9070	79.5520	0.0000	-0.5599	0.0000
6	45.3188	69.9549	0.0000	44.9813	0.0000
7	46.3745	70.0438	10285.6	28058.7	-58282.3
8	78.63	70.00	497.42	1366.79	-1521.66
9	20968146.0	20909843.3	80.4782	28.4752	28.3146
10	-0.001	0.006	27381554.0	298.6478	-40.7458
11	813935.406	-77123.416	91.0347	72.0303	342.9808
12	5368.8				2159.99
13	164.47	2691.54	396.16	4.09	97.91
1	100.0000	74653.3	8547642.8	3194560.8	47155.5
2	3762.8	2681.7	0.14528	-109.766	84.022
3	2.803	205056.8184	0.0817	-0.0404	0.0911
4	84.48	390.76	30.59703	466.21	42.48
5	27.6364	77.9318	0.0000	-0.4931	0.0000
6	40.0687	70.0336	-0.0000	39.6492	-0.0000
7	40.6616	70.1106	16218.3	44381.0	-74601.1
8	45.11	70.00	695.60	1915.79	-1742.77
9	20984480.3	20909826.8	80.4276	28.4914	28.3309
10	-0.000	0.001	27380318.5	298.6677	-40.6984
11	83642.219	-41336.645	96.0253	71.9524	341.3594
12	6198.2				2716.05
13	191.13	2910.94	402.69	4.09	97.92
1	110.0000	93273.6	8574068.1	2912456.2	70805.7
2	4484.5	3371.8	0.17322	-114.010	93.596
3	3.440	101546.1250	0.1910	-0.0357	0.1943
4	35.30	408.55	31.11140	293.43	57.02
5	26.1342	76.6237	0.0000	-0.4312	0.0000
6	35.6084	70.1125	0.0000	35.0894	0.0000
7	35.9166	70.1805	24326.5	66735.9	-93154.2
8	45.11	70.00	932.58	2573.60	-1968.66
9	21003077.5	20909804.0	80.3584	28.5134	28.3530
10	-0.000	0.001	27376164.0	298.6950	-40.6394
11	79294.078	-14803.285	100.2659	71.7739	339.9623
12	7104.3				3408.40
13	206.79	3108.03	405.91	4.09	97.92
1	120.0000	114240.6	8585831.4	2630351.7	101957.4
2	5322.4	4183.4	0.20569	-119.225	104.455
3	4.141	46248.9570	0.4643	-0.0333	0.4655
4	13.41	438.32	31.55700	161.54	75.20
5	24.5830	75.5903	0.0000	-0.3270	0.0000
6	31.8598	70.1960	-0.0000	31.2208	-0.0000
7	32.0102	70.2581	35005.5	96235.2	-113992.5
8	78.46	70.00	1210.22	3345.98	-2200.23
9	21024015.3	20909774.5	80.2672	28.5424	28.3820
10	-0.000	0.002	27368332.8	298.7308	-40.5672
11	75365.645	-5403.729	103.8313	71.5397	338.7615
12	8102.7				4250.18
13	214.79	3285.41	407.29	4.10	97.94

1	130.0000	137673.2	8590118.9	2348247.2	141834.8
2	6290.3	5130.0	0.24323	-125.867	117.390
3	4.885	22285.5867	0.7742	-0.0315	0.7749
4	5.43	479.29	31.93465	91.02	70.52
5	23.0996	74.7824	0.0000	-0.2658	0.0000
6	28.8558	70.2868	0.0000	28.0729	0.0000
7	28.8089	70.3468	48678.0	134071.9	-137190.7
8	127.86	70.00	1532.16	4243.63	-2441.63
9	21047409.0	20909736.5	80.1503	28.5794	28.4190
10	-0.000	0.002	27356031.8	298.7766	-40.4802
11	38454.258	-1562.859	106.6922	71.2924	337.7738
12	9214.5				5242.45
13	219.02	3445.80	407.90	4.10	98.00
1	140.0000	163778.0	8591888.4	2066142.7	191806.6
2	7413.0	6235.7	0.28682	-134.720	133.626
3	5.789	10741.9510	0.9309	-0.0295	0.9314
4	2.14	508.70	32.25314	50.30	46.85
5	21.7702	74.1536	0.0000	-0.2658	0.0000
6	26.3696	70.3888	0.0000	25.4150	0.0000
7	26.2155	70.4488	65818.6	181588.9	-162894.4
8	182.90	70.00	1905.35	5286.41	-2703.28
9	21073467.0	20909689.3	80.0037	28.6254	28.4651
10	-0.000	0.001	27338421.5	298.8339	-40.3761
11	4885.426	-154.582	109.0662	71.0429	336.9332
12	10468.9				6400.32
13	221.31	3591.86	408.18	4.11	98.16
1	148.3153	187762.3	8592540.4	1831564.3	242212.2
2	8492.3	7303.3	0.32877	-144.685	150.835
3	7.087	5999.3107	0.9117	-0.0278	0.9121
4	0.92	468.12	32.48088	32.58	29.72
5	20.7850	73.7392	0.0000	-0.2148	0.0000
6	24.5463	70.4851	-0.0000	23.4248	-0.0000
7	24.4238	70.5458	83118.0	229621.4	-186351.0
8	233.47	70.00	2263.60	6289.30	-2942.70
9	21097403.8	20909642.0	79.8556	28.6717	28.5114
10	-0.000	0.001	27319054.3	298.8917	-40.2746
11	-12748.309	389.050	110.8131	70.8303	336.2999
12	11649.9				7516.52
13	222.41	3704.09	408.28	4.11	98.30
*	CENTER ENGINE SHUTDOWN				
1	148.3153	187762.3	6874030.4	1831564.3	242212.2
2	8492.3	7303.3	0.32877	-144.685	120.647
3	7.087	5999.3107	0.9117	-0.0278	0.9121
4	0.92	468.12	32.48088	32.58	29.72
5	20.7850	73.7392	0.0000	-0.2148	0.0000
6	24.5463	70.4851	-0.0000	23.4248	-0.0000
7	24.4238	70.5458	83118.0	229621.4	-186351.0
8	233.47	70.00	2263.60	6289.30	-2942.70
9	21097403.8	20909642.0	79.8556	28.6717	28.5114
10	-0.000	0.001	27319054.3	298.8917	-40.2746
11	-12748.309	389.050	110.8131	70.8303	336.2999
12	11649.9				7516.52
13	222.41	3704.09	408.28	4.11	98.30

1	150.0000	192880.8	6874098.4	1793543.4	253472.3	
2	8678.1	7486.9	0.33600	-146.961	123.217	
3	7.400	5336.7370	0.9193	-0.0277	0.9197	
4	0.77	451.84	32.51499	29.43	27.07	
5	20.5785	73.6840	0.0000	-0.2148	0.0000	
6	24.2210	70.5059	0.0000	23.0629	0.0000	
7	24.0961	70.5669	86984.0	240364.6	-191334.6	
8	244.26	70.00	2326.26	6465.22	-2973.73	
9	21102511.5	20909631.3	79.8225	28.6820	28.5217	
10	-0.000	0.001	27314562.3	298.9046	-40.2524	
11	-14472.855	436.032	111.1258	70.7895	336.1851	
12	11855.5				7710.51	
13	222.58	3725.93	408.29	4.12	98.33	
GP1	417.6250	337.656	74.43850	30.01407	9365.224	-28.887595
GP2	-176.49689	-830.6918	352.201	70.62600	30.18104	76.86576
GP3	0.9018148	180.701	156149.508	177.63898	0.3360044	32.51499
GP4	33.00563	3500.113	8061.550		882.0209	44421428.

1	152.3153	200017.5	6874174.3	1741290.8	269453.3	
2	8941.2	7746.9	0.34625	-150.342	126.932	
3	7.857	4490.6017	0.8961	-0.0270	0.8965	
4	0.59	429.16	32.56074	25.53	22.89	
5	20.3024	73.6116	0.0000	-0.2148	0.0000	
6	23.7755	70.5352	-0.0000	22.5655	-0.0000	
7	23.6606	70.5965	92472.0	255620.0	-198270.0	
8	252.63	70.00	2414.85	6714.02	-3017.42	
9	21109633.8	20909616.3	79.7755	28.6966	28.5363	
10	-0.000	0.001	27308098.3	298.9229	-40.2209	
11	-15779.379	475.185	111.5545	70.7320	336.0270	
12	12145.3				7978.92	
13	222.79	3755.48	408.31	4.12	98.37	
GP1	426.5221	358.943	74.04471	30.11143	9633.197	-28.491292
GP2	-176.29965	-832.9013	372.228	70.64651	30.27873	76.98272
GP3	0.8953969	193.293	150722.662	177.50276	0.3462467	32.56074
GP4	33.20661	3502.448	8318.076		885.2888	46963633.

* OUTBOARD ENGINE SHUTDOWN AND S-IC/S-II STAGING

1	152.3153	200017.5	0.0	1389814.0	269453.3	
2	8941.2	7746.9	0.34625	-173.085	-0.104	
3	7.857	4490.6017	0.8961	-0.0270	0.8965	
4	0.59	429.16	32.56074	25.53	22.89	
5	20.3024	73.6116	0.0000	-0.2148	0.0000	
6	23.7755	70.5352	-0.0000	22.5655	-0.0000	
7	23.6606	70.5965	92472.0	255620.0	-198270.0	
8	252.63	70.00	2414.85	6714.02	-3017.42	
9	21109633.8	20909616.3	79.7755	28.6966	28.5363	
10	-0.000	0.001	27308098.3	298.9229	-40.2209	
11	-42127.838	1268.652	111.5545	70.7320	336.0270	
12	12145.3				7978.92	
13	222.79	3755.48	408.31	4.12	98.37	
GP1	426.5221	358.943	74.04471	30.11143	9633.197	-28.491292
GP2	-176.29965	-832.9013	372.228	70.64651	30.27873	76.98272
GP3	0.8953969	193.293	150722.662	177.50276	0.3462467	32.56074
GP4	33.20661	3502.448	8318.076		885.2888	46963633.

F001 GIMBAL STATION EQUAL ZERO, L SET EQUAL 0

1	156.1153	211627.4	0.0	1389814.0	296154.0	
2	8899.9	7699.3	0.34474	0.000	0.000	
3	8.034	0.0000	11.3156	-0.0268	11.3157	
4	0.34	405.64	32.56020	15.31	173.22	
5	19.6651	73.6579	0.0000	-0.0789	0.0000	
6	33.4961	70.5032	-0.0000	32.2001	-0.0000	
7	22.9452	70.6457	101643.8	281128.2	-209514.9	
8	252.63	70.00	2412.43	6711.44	-2901.02	
9	21121218.8	20909591.3	79.6970	28.7210	28.5607	
10	0.000	0.000	27297078.5	298.9535	-40.1688	
11	0.000	0.000	102.3627	71.6890	339.2959	
12	12145.3				7932.53	
13	223.02	3802.83	408.31	4.13	98.37	
GP1	426.5177	358.924	74.04503	30.11123	9632.908	-28.492091
GP2	-176.29983	-832.8965	367.016	70.64758	30.27853	76.98371
GP3	0.8954047	193.278	150728.936	177.58935	0.3447414	32.56020
GP4	33.20639	3502.447	8317.767		889.0847	46960864.

* S-II LIFTOFF

1	156.1153	211627.4	999945.0	1384339.0	296154.0	
2	8899.9	7699.3	0.34474	0.000	23.240	
3	8.034	0.0000	11.3156	-0.0268	11.3157	
4	0.34	405.64	32.56020	15.31	173.22	
5	19.6651	73.6579	0.0000	-0.0789	0.0000	
6	33.4961	70.5032	-0.0000	32.2001	-0.0000	
7	22.9452	70.6457	101643.8	281128.2	-209514.9	
8	252.63	70.00	2412.43	6711.44	-2901.02	
9	21121218.8	20909591.3	79.6970	28.7210	28.5607	
10	0.000	0.000	27297078.5	298.9535	-40.1688	
11	0.000	0.000	102.3627	71.6890	339.2959	
12	12145.3				7932.53	
13	223.02	3802.83	408.31	4.13	98.37	
GP1	426.5177	358.924	74.04503	30.11123	9632.908	-28.492091
GP2	-176.29983	-832.8965	367.016	70.64758	30.27853	76.98371
GP3	0.8954047	193.278	150728.936	177.58935	0.3447414	32.56020
GP4	33.20639	3502.447	8317.767		889.0847	46960864.

1	160.0000	223171.9	999968.3	1375220.0	323558.8	
2	8946.9	7741.2	0.34666	0.000	23.395	
3	8.321	0.0000	11.6854	-0.0258	11.6854	
4	0.19	382.25	32.57265	9.45	110.38	
5	19.1523	73.6771	0.0000	-0.0789	0.0000	
6	33.2782	70.5490	-0.0000	31.8936	-0.0000	
7	22.3357	70.6957	111060.8	307334.6	-220648.4	
8	252.63	70.00	2435.85	6780.77	-2830.95	
9	21132737.0	20909565.8	79.6163	28.7459	28.5856	
10	0.000	0.000	27285506.8	298.9849	-40.1159	
11	0.000	0.000	102.5842	71.6739	339.2249	
12	12235.9				7975.45	
13	223.02	3849.89	408.31	4.13	100.19	
GP1	430.0077	366.117	73.91172	30.14372	9713.945	-28.429531
GP2	-176.23475	-833.3186	369.615	70.65543	30.31113	77.03095
GP3	0.8935401	196.969	149236.354	177.61116	0.3466571	32.57265
GP4	33.26869	3503.376	8390.466		892.7951	47743659.

1	170.0000	251830.5	999991.5	1351745.8	395291.9	
2	9075.0	7857.0	0.35186	0.000	23.802	
3	9.177	0.0000	12.6078	-0.0231	12.6079	
4	0.05	323.72	32.60416	3.08	38.90	
5	17.8611	73.7294	0.0000	-0.0789	0.0000	
6	32.7204	70.6690	-0.0000	31.1046	-0.0000	
7	20.8006	70.8270	135723.8	376045.3	-248057.7	
8	252.63	70.00	2496.95	6962.04	-2651.02	
9	21161328.3	20909498.8	79.4050	28.8109	28.6506	
10	0.000	0.000	27254112.5	299.0670	-39.9798	
11	0.000	0.000	103.1540	71.6325	339.0419	
12	12471.8				8093.66	
13	223.02	3965.32	408.31	4.13	105.48	
GP1	438.9179	384.857	73.56403	30.22761	9923.481	-28.240646
GP2	-176.06545	-834.6295	376.314	70.67545	30.39530	77.15600
GP3	0.8885768	206.831	145444.123	177.66889	0.3518593	32.60416
GP4	33.43312	3505.698	8580.982		902.4400	49798169.

1	176.1153	268612.5	999996.5	1337390.7	440018.5	
2	9158.4	7933.4	0.35523	0.000	24.057	
3	9.653	0.0000	13.1502	-0.0213	13.1503	
4	0.02	298.20	32.62305	1.41	18.51	
5	17.0926	73.7635	0.0000	-0.0789	0.0000	
6	32.3817	70.7440	0.0000	30.6221	0.0000	
7	19.8867	70.9089	151109.2	418964.6	-263933.9	
8	252.63	70.00	2534.91	7074.94	-2541.29	
9	21178069.0	20909457.3	79.2730	28.8512	28.6909	
10	0.000	0.000	27233766.0	299.1182	-39.8965	
11	0.000	0.000	103.5020	71.6054	338.9300	
12	12618.2				8171.38	
13	223.02	4031.94	408.31	4.13	109.16	
GP1	444.3164	396.478	73.34810	30.27910	10052.384	-28.106587
GP2	-175.96062	-835.5930	380.421	70.68761	30.44695	77.23494
GP3	0.8854217	213.127	143160.061	177.70534	0.3552314	32.62305
GP4	33.53672	3507.067	8699.927		908.4089	51083891.

* LES AND S-IC/S-II INTERSTAGE (FWD) JETTISON

1	176.1153	268612.5	999996.5	1321340.7	440018.5	
2	9158.4	7933.4	0.35523	0.000	24.349	
3	9.653	0.0000	13.1502	-0.0213	13.1503	
4	0.02	298.20	32.62305	1.41	18.51	
5	17.0926	73.7635	0.0000	-0.0789	0.0000	
6	32.3817	70.7440	0.0000	30.6221	0.0000	
7	19.8867	70.9089	151109.2	418964.6	-263933.9	
8	252.63	70.00	2534.91	7074.94	-2541.29	
9	21178069.0	20909457.3	79.2730	28.8512	28.6909	
10	0.000	0.000	27233766.0	299.1182	-39.8965	
11	0.000	0.000	103.5020	71.6054	338.9300	
12	12618.2				8171.38	
13	223.02	4031.94	408.31	4.13	109.16	
GP1	444.3164	396.478	73.34810	30.27910	10052.384	-28.106587
GP2	-175.96062	-835.5930	380.421	70.68761	30.44695	77.23494
GP3	0.8854217	213.127	143160.061	177.70534	0.3552314	32.62305
GP4	33.53672	3507.067	8699.927		908.4089	51083891.

1	180.0000	278984.9	999998.0	1312221.7	468778.2
2	9214.4	7985.2	0.35749	0.000	24.519
3	9.715	0.0000	13.4840	-0.0201	13.4840
4	0.01	298.20	32.63506	0.82	11.01
5	16.6149	73.7857	0.0000	-0.0789	0.0000
6	32.1674	70.7923	0.0000	30.3157	0.0000
7	19.3182	70.9615	161004.4	446591.1	-273672.0
8	252.63	70.00	2559.59	7148.39	-2472.28
9	21188415.0	20909430.8	79.1882	28.8770	28.7167
10	0.000	0.000	27220384.8	299.1512	-39.8436
11	0.000	0.000	103.7230	71.5874	338.8589
12	12713.1				8223.98
13	223.02	4072.73	408.31	4.13	111.71
GP1	447.7703	404.019	73.20785	30.31229	10135.617 -28.013460
GP2	-175.89266	-836.2771	383.136	70.69536	30.48026 77.28674
GP3	0.8833435	217.285	141705.346	177.72809	0.3574910 32.63506
GP4	33.60461	3507.927	8777.397		912.2290 51922914.

1	190.0000	304674.4	999999.5	1288747.5	544088.7
2	9365.5	8126.2	0.36357	0.000	24.965
3	9.721	0.0000	14.3100	-0.0170	14.3100
4	0.00	308.28	32.66541	0.19	2.75
5	15.4169	73.8458	0.0000	-0.0789	0.0000
6	31.6195	70.9188	0.0000	29.5267	0.0000
7	17.8933	71.0996	186921.3	519031.9	-297508.0
8	252.63	70.00	2624.01	7340.52	-2295.00
9	21214034.8	20909361.3	78.9656	28.9443	28.7839
10	0.000	0.000	27184294.8	299.2374	-39.7071
11	0.000	0.000	104.2910	71.5386	338.6758
12	12960.5				8366.96
13	223.02	4172.39	408.31	4.13	118.96
GP1	456.6031	423.685	72.84160	30.39804	10351.314 -27.750482
GP2	-175.71552	-838.2728	390.157	70.71524	30.56628 77.42388
GP3	0.8778089	228.404	138009.857	177.78830	0.3635749 32.66541
GP4	33.78425	3510.072	8980.453		922.1791 54129444.

1	200.0000	328929.3	999999.9	1265273.3	621282.9
2	9526.7	8278.3	0.37004	0.000	25.429
3	9.150	0.0000	15.0798	-0.0136	15.0798
4	0.00	360.83	32.69499	0.03	0.38
5	14.2653	73.9104	0.0000	-0.0823	0.0000
6	31.0698	71.0488	-0.0000	28.7309	-0.0000
7	16.5251	71.2411	213488.9	593416.5	-319573.5
8	252.63	70.00	2689.74	7537.15	-2118.17
9	21238218.5	20909290.5	78.7372	29.0128	28.8524
10	0.000	0.000	27145815.3	299.3257	-39.5704
11	0.000	0.000	104.8644	71.4854	338.4903
12	13212.4				8520.73
13	223.02	4264.59	408.31	4.13	127.21
GP1	465.3672	443.741	72.46738	30.48427	10569.348 -27.456310
GP2	-175.53499	-840.6101	397.245	70.73500	30.65280 77.56681
GP3	0.8719971	240.151	134383.879	177.85081	0.3700414 32.69499
GP4	33.97137	3512.118	9188.866		932.3051 56407203.

SATURN V / LOR VEHICLE

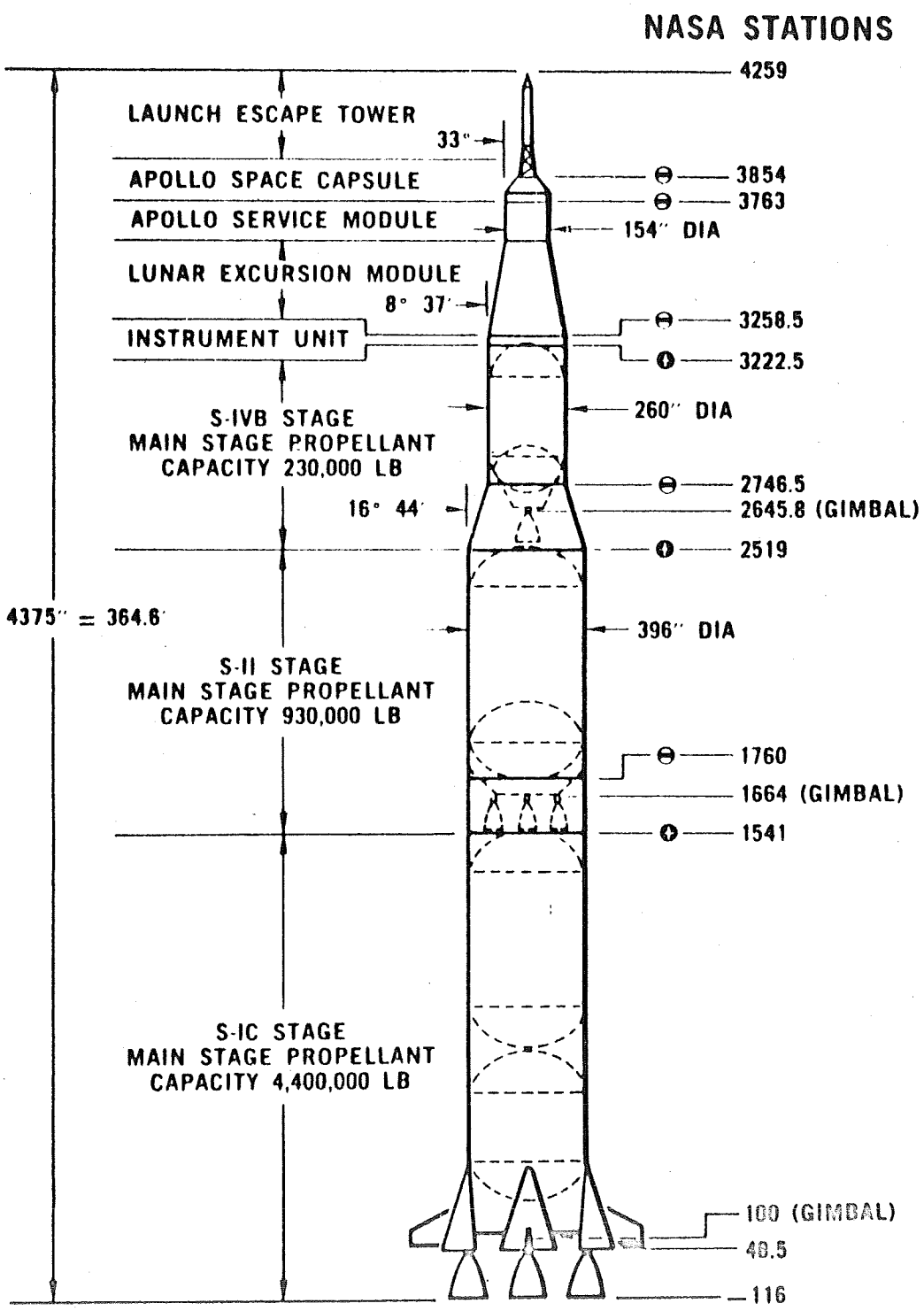


FIGURE 1

SATURN V
ATMOSPHERIC DENSITY AS A FUNCTION OF GEOMETRIC ALTITUDE

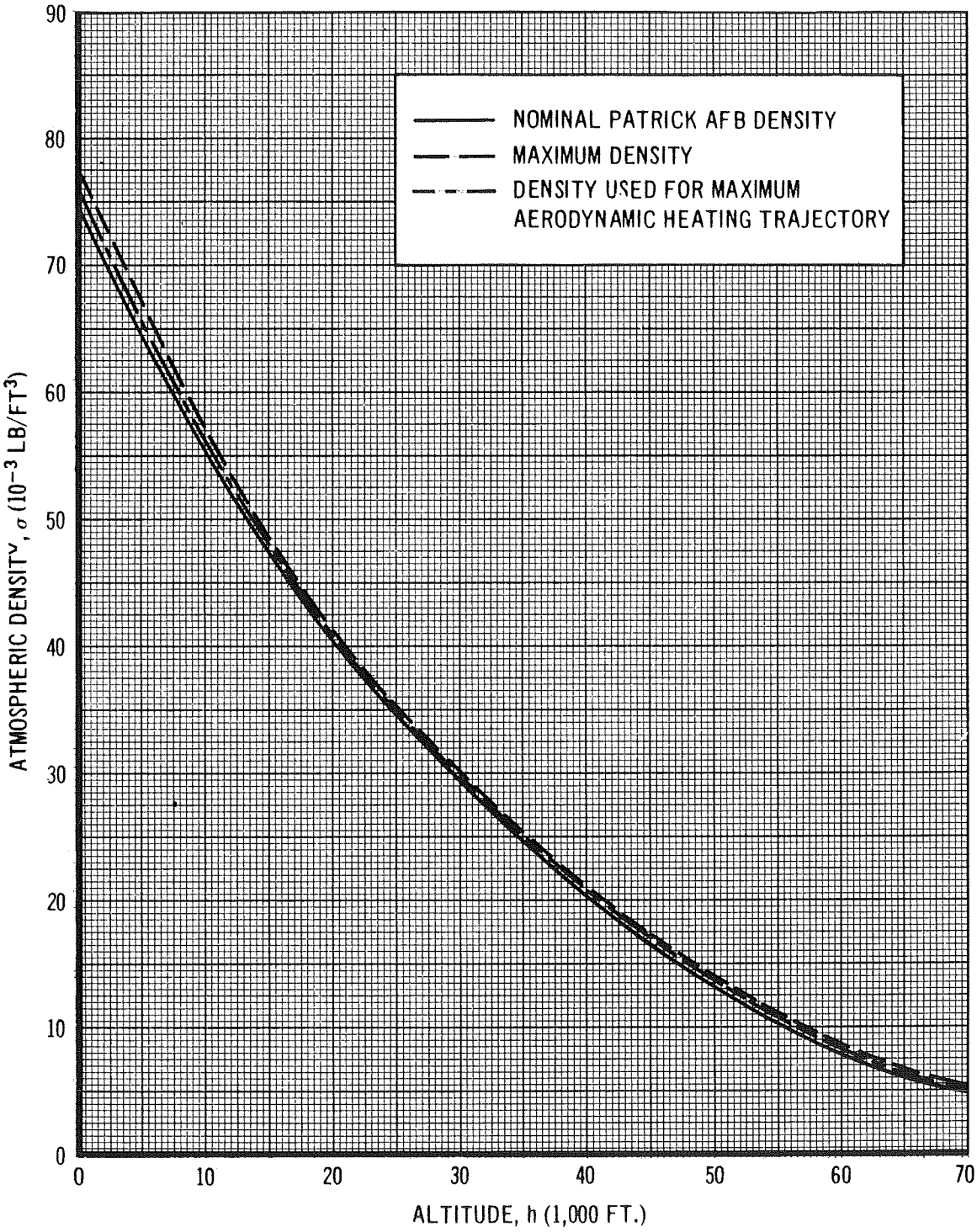


FIGURE 2
(SHEET 1)

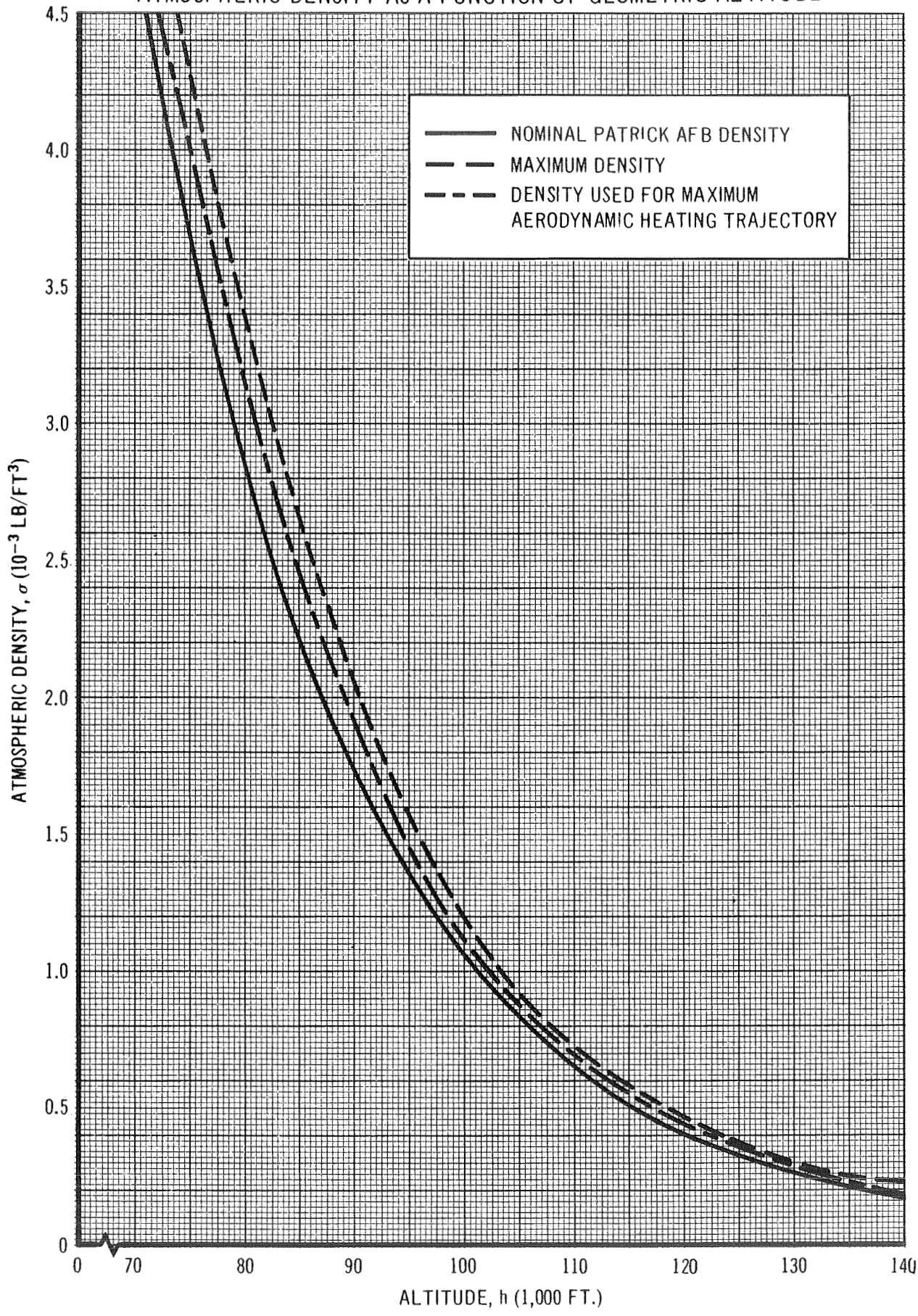


FIGURE 2
(SHEET 2)

SATURN V
ATMOSPHERIC DENSITY AS A FUNCTION OF GEOMETRIC ALTITUDE

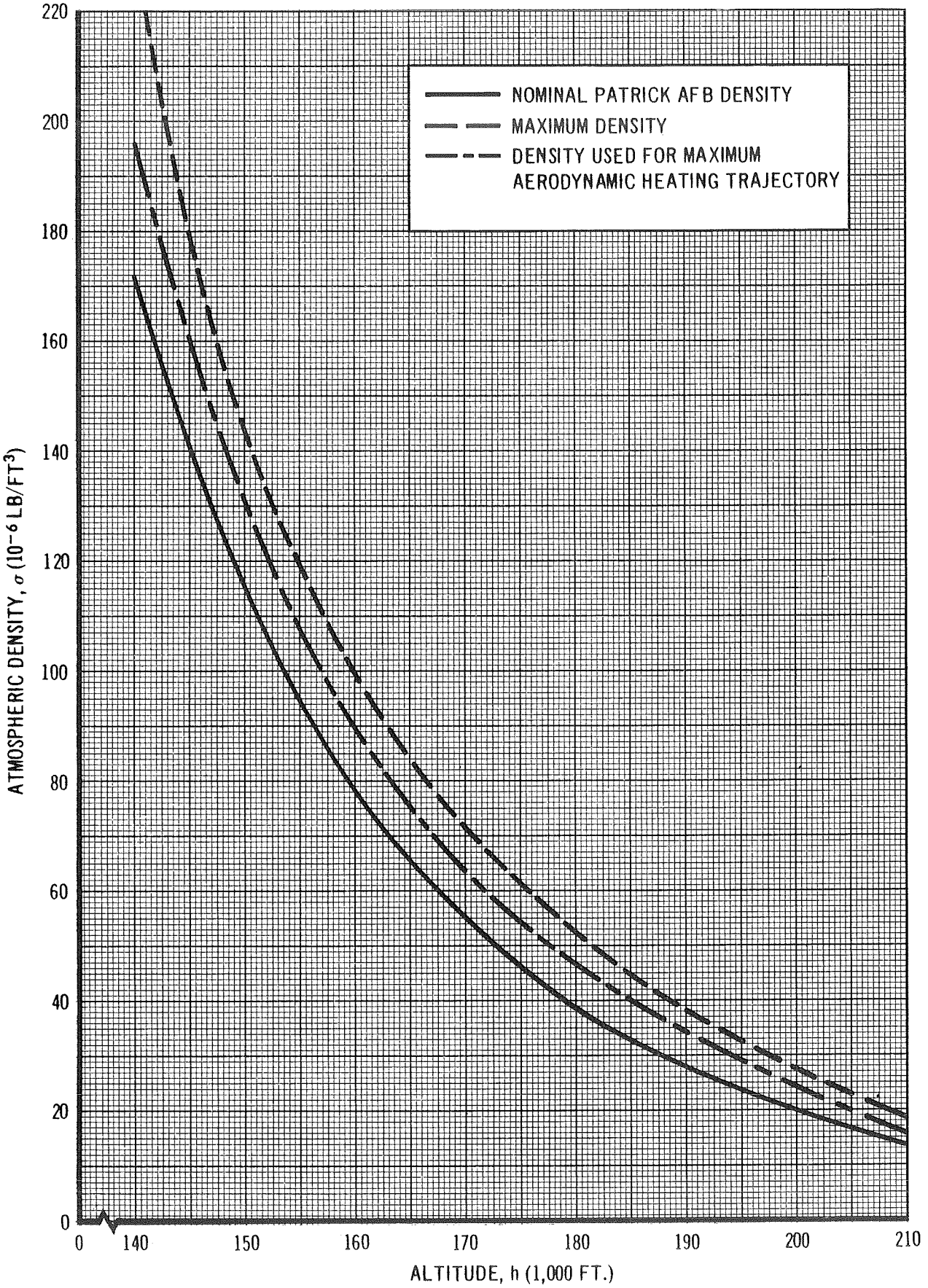


FIGURE 2
(SHEET 3)

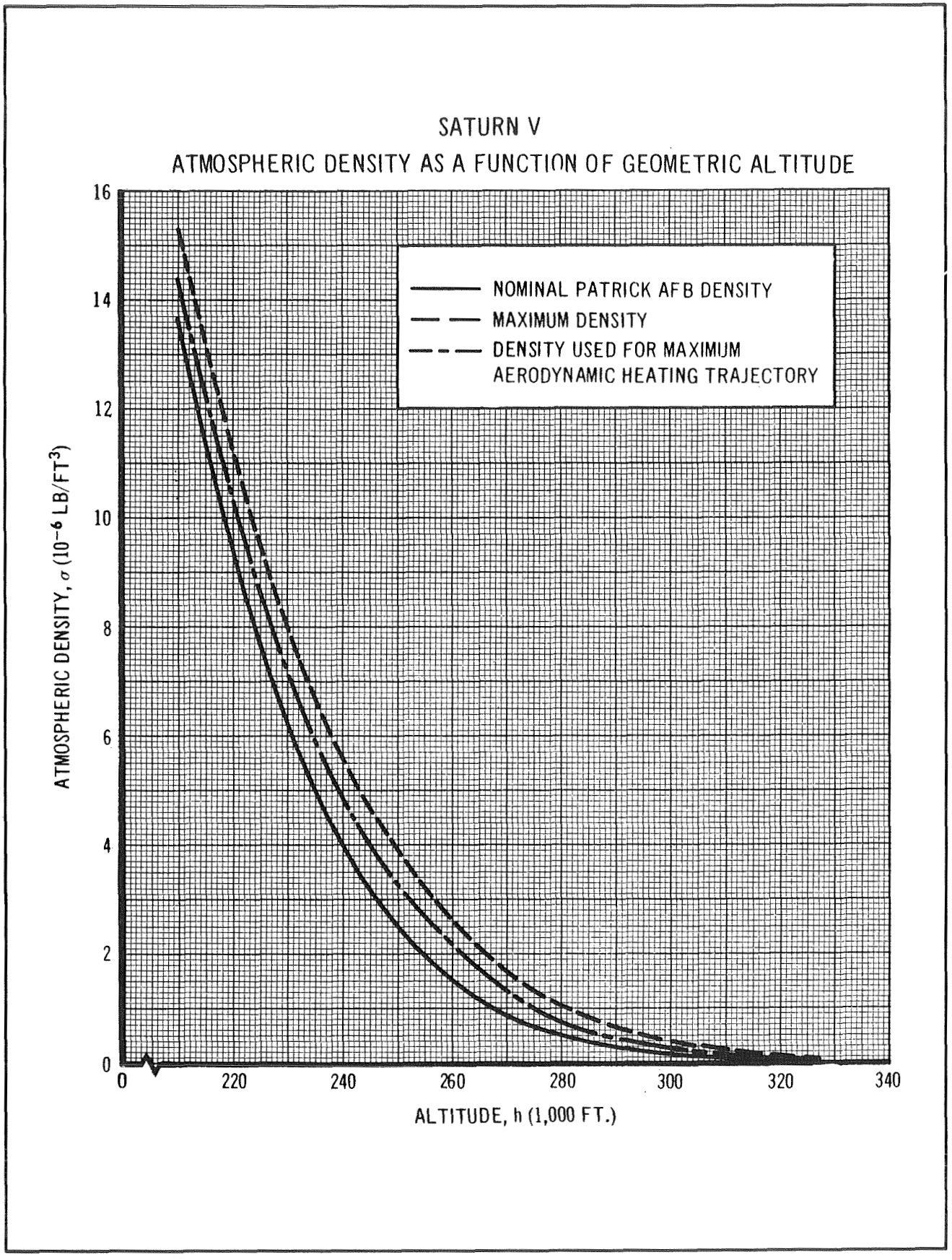


FIGURE 2
(SHEET 4)

SATURN V

ATMOSPHERIC PRESSURE AS A FUNCTION OF GEOMETRIC ALTITUDE

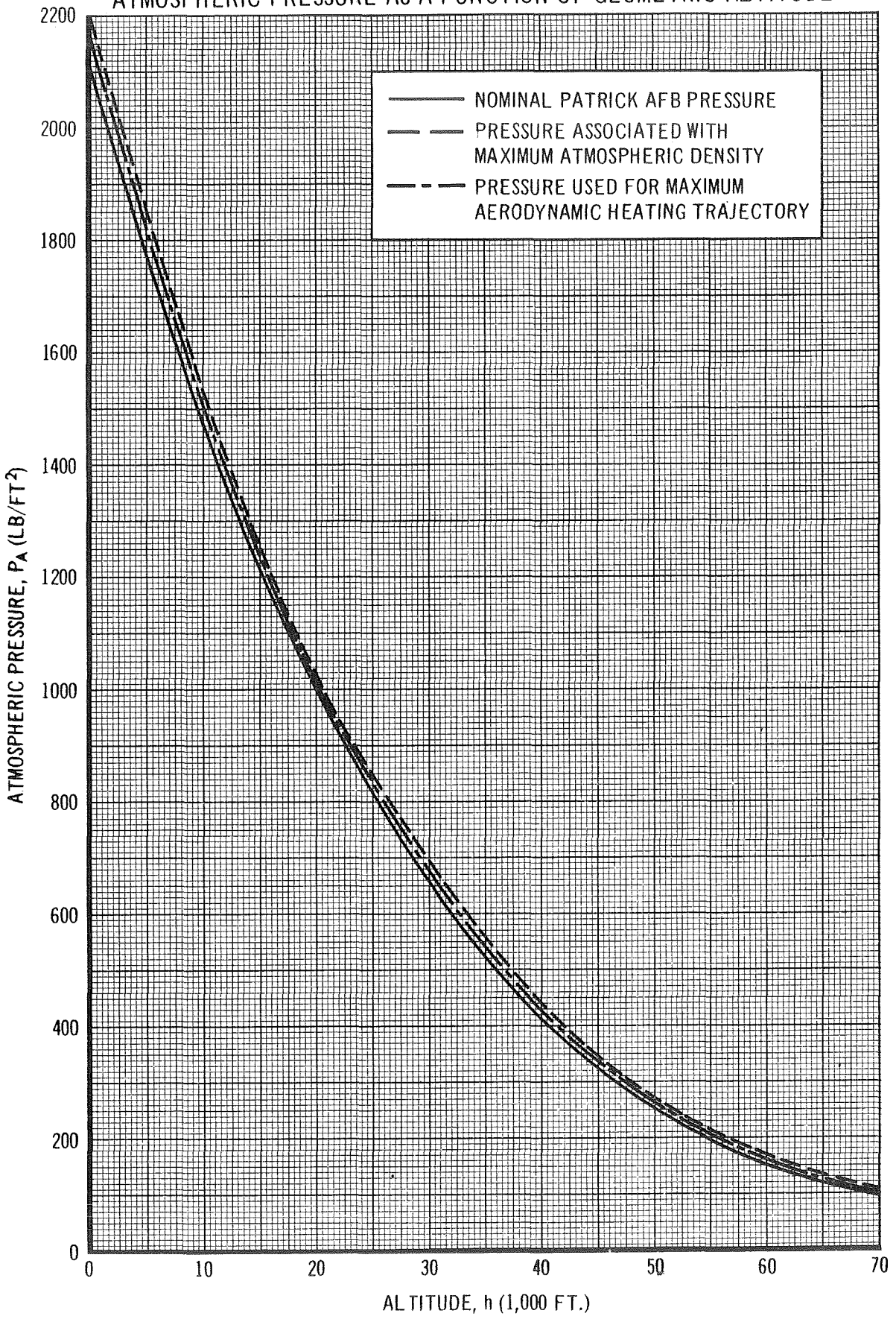


FIGURE 3
(SHEET 1)

SATURN V
ATMOSPHERIC PRESSURE AS A FUNCTION OF GEOMETRIC ALTITUDE

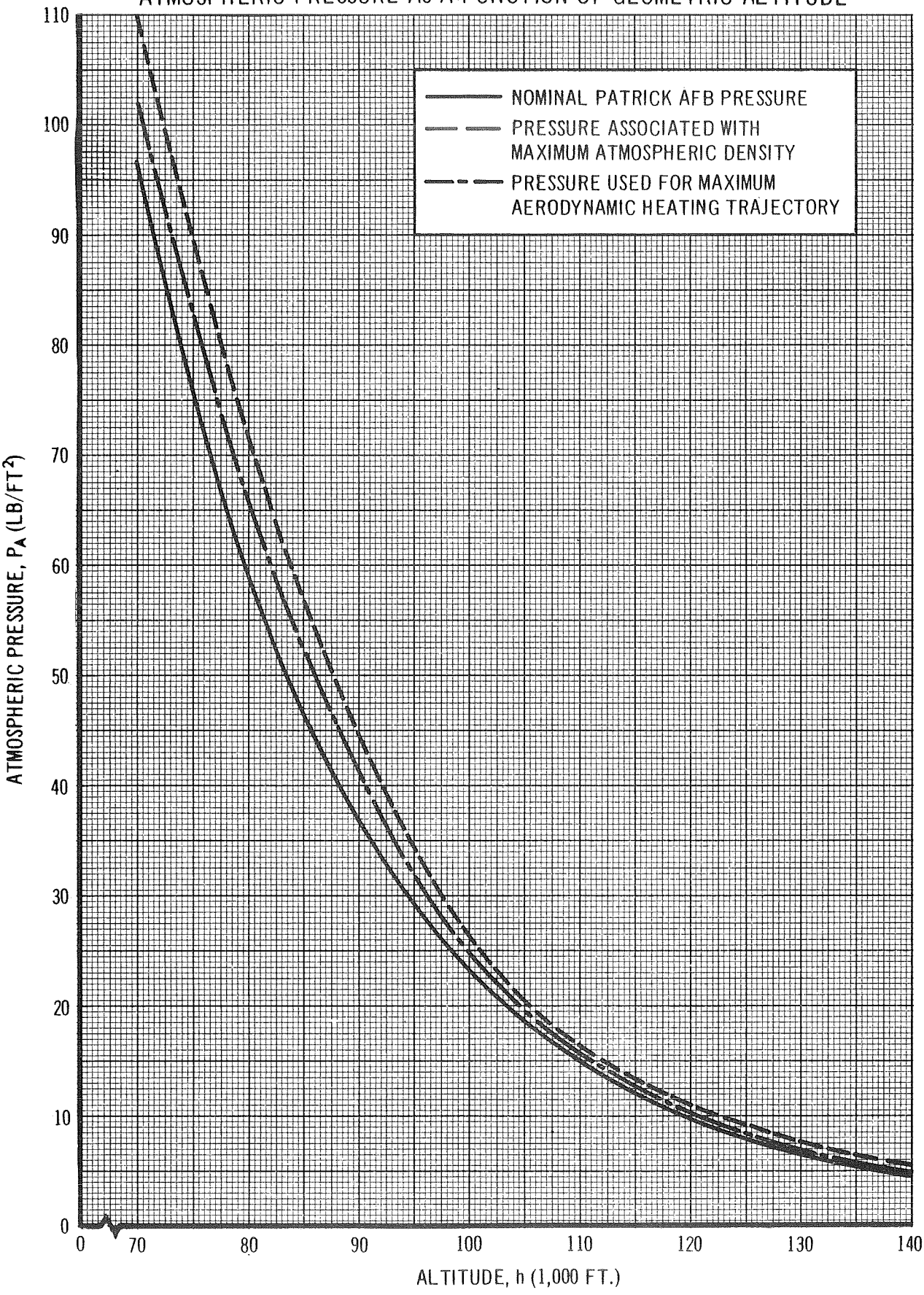


FIGURE 3
(SHEET 2)

SATURN V

ATMOSPHERIC PRESSURE AS A FUNCTION OF GEOMETRIC ALTITUDE

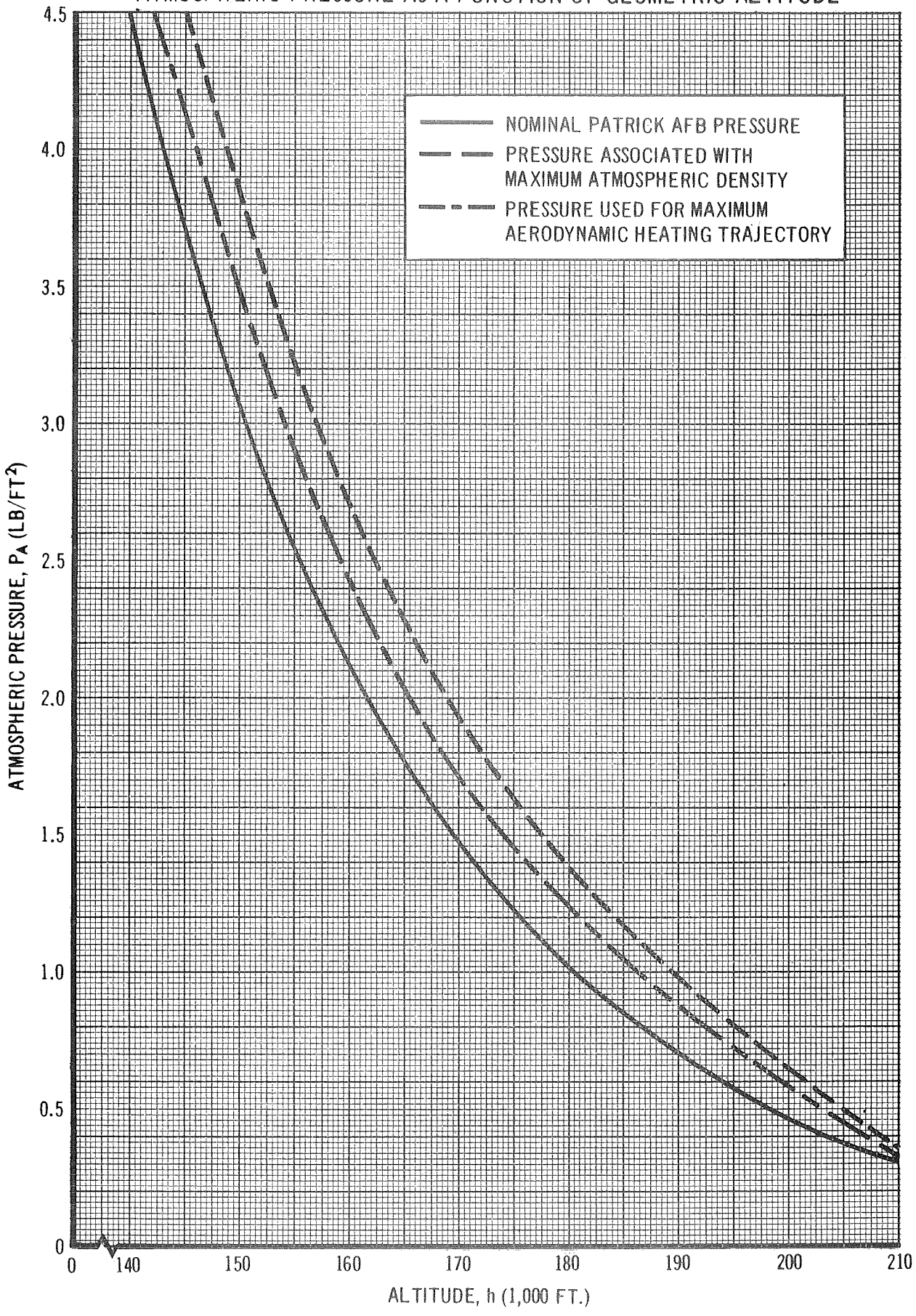


FIGURE 3
(SHEET 3)

SATURN V

ATMOSPHERIC PRESSURE AS A FUNCTION OF GEOMETRIC ALTITUDE

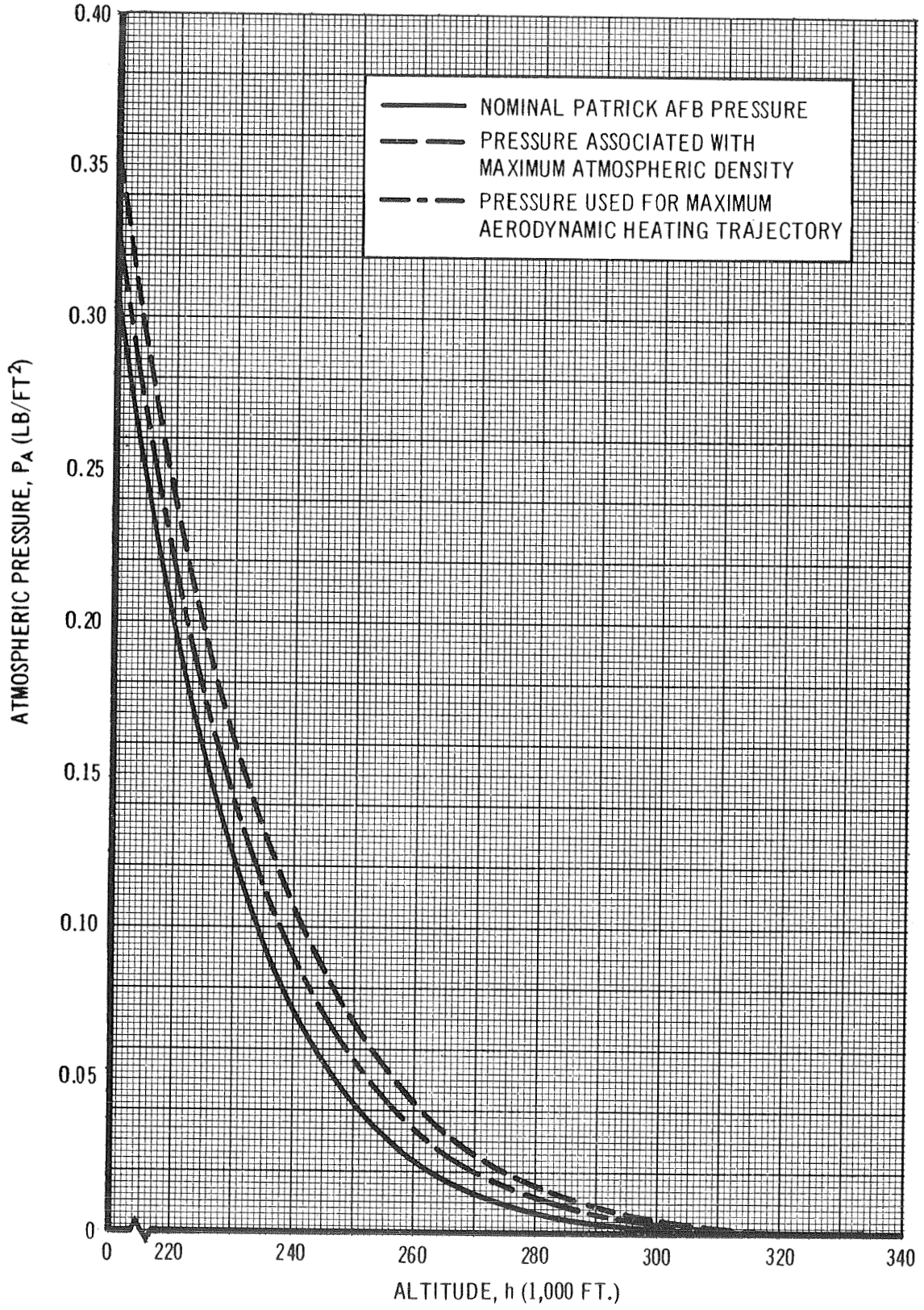


FIGURE 3
(SHEET 4)

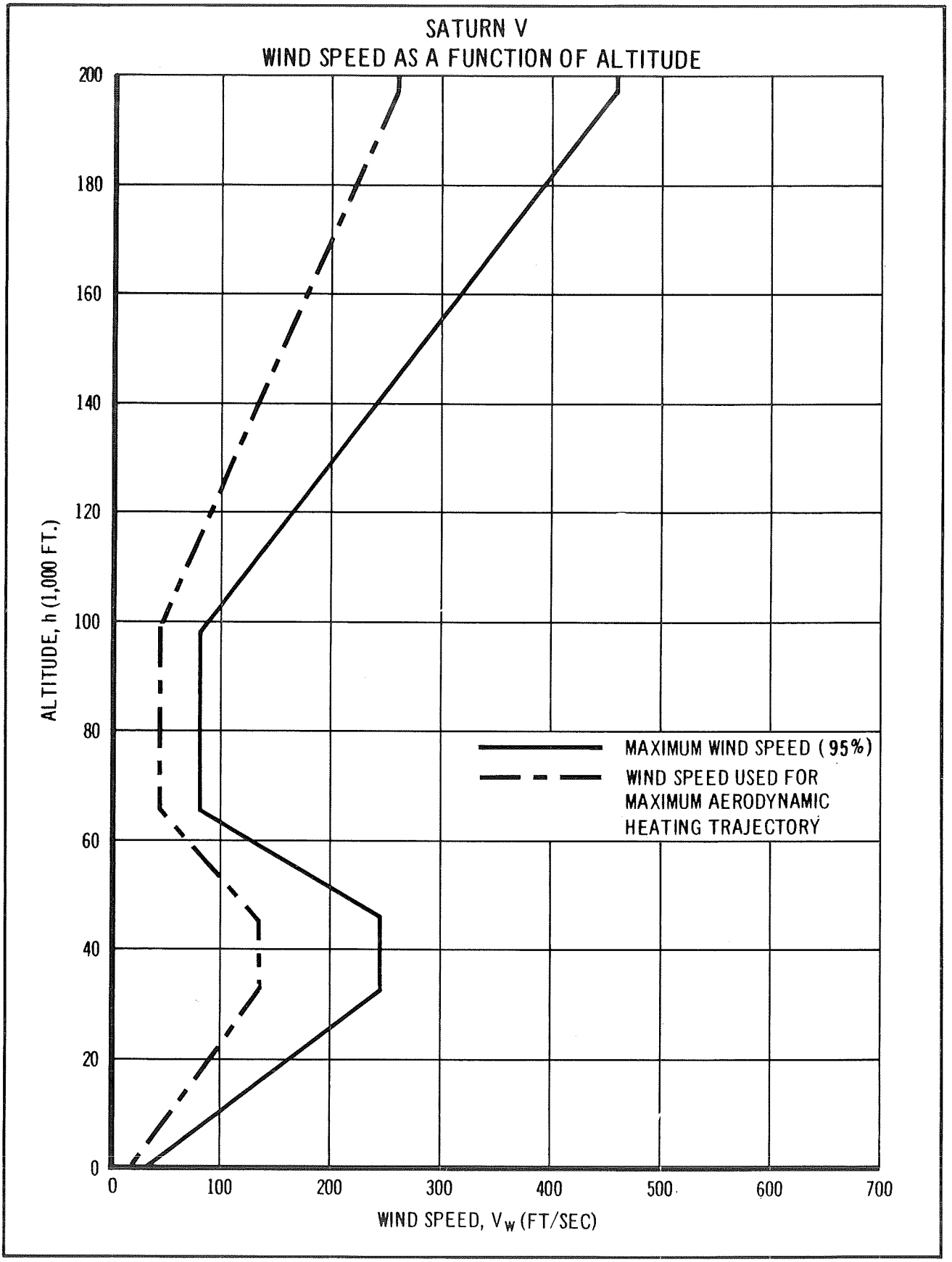
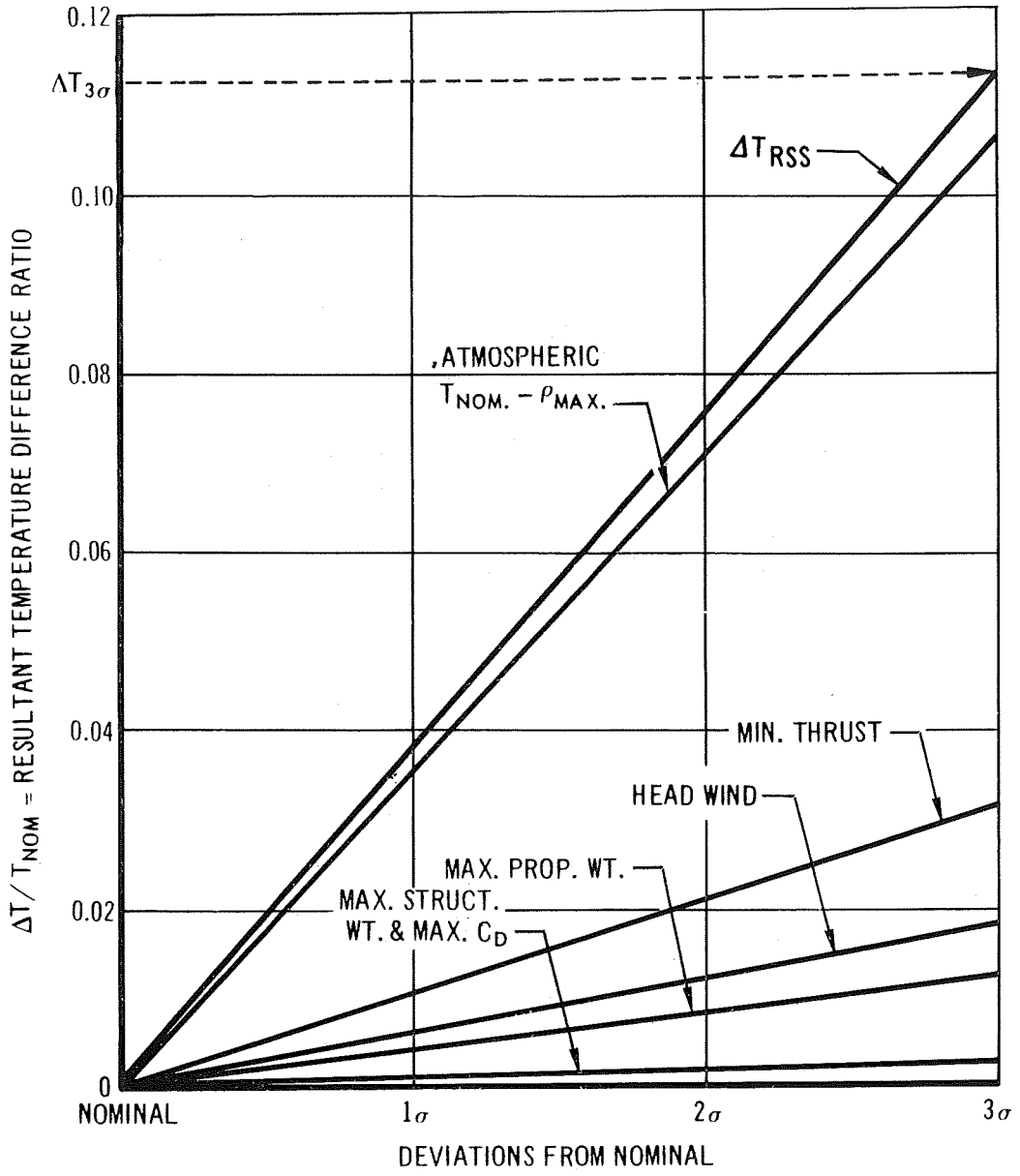

SATURN V
WIND SPEED AS A FUNCTION OF ALTITUDE
ALTITUDE, h (1,000 FT.)
200
180
160
140
120
100
80
60
40
20
0
0
100
200
300
400
500
600
700
WIND SPEED, V_W (FT/SEC)
MAXIMUM WIND SPEED (95%)
WIND SPEED USED FOR MAXIMUM AERODYNAMIC HEATING TRAJECTORY

FIGURE 4

SATURN V

COMPARISON OF PARAMETER TEMPERATURE CONTRIBUTIONS

AFT INTERSTAGE



AFT INTERSTAGE T_{NOM} 491°F (PEAK TEMPERATURE)

FIGURE 5

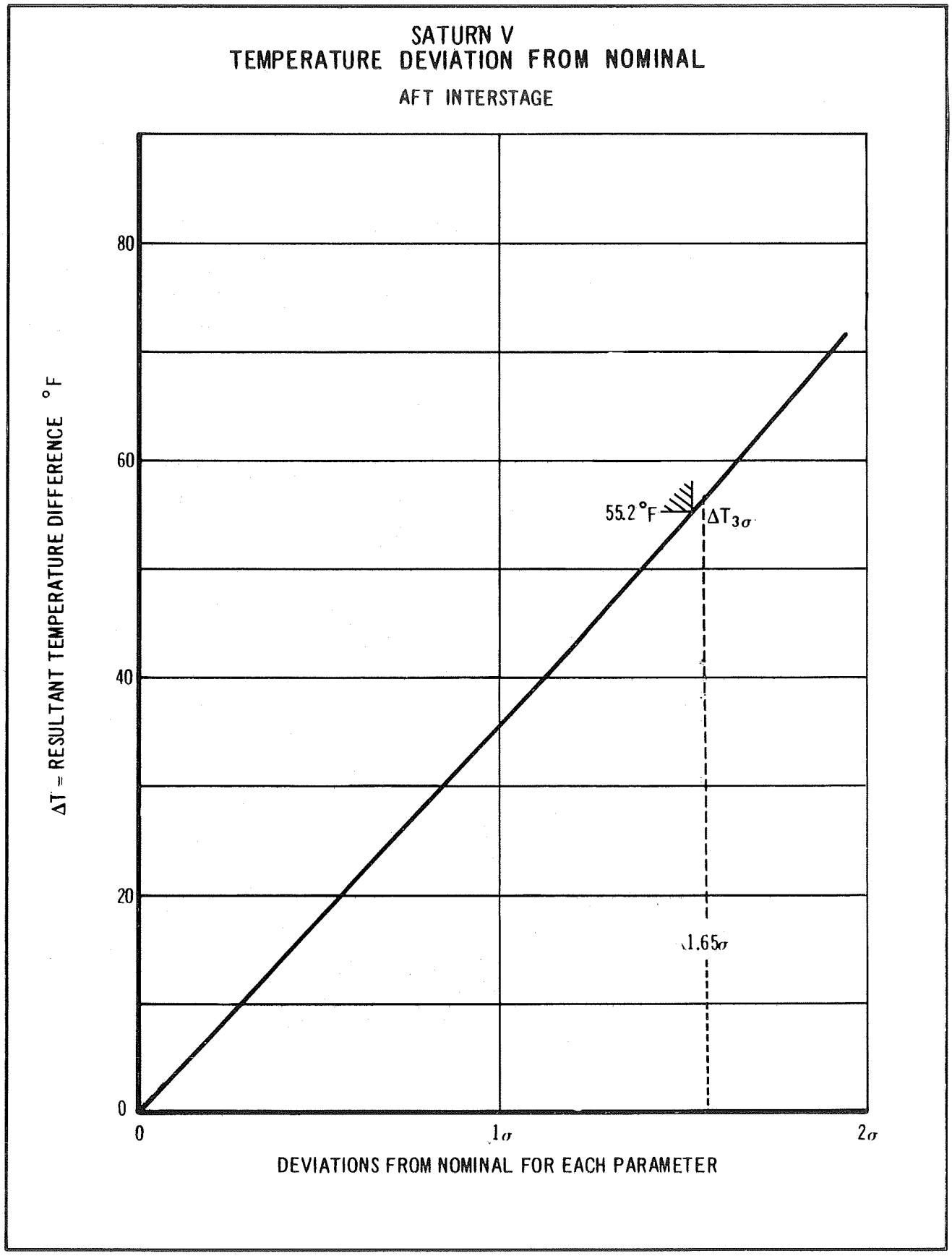

SATURN V
TEMPERATURE DEVIATION FROM NOMINAL
AFT INTERSTAGE
ΔT = RESULTANT TEMPERATURE DIFFERENCE °F
80
60
40
20
0
55.2°F
ΔT3σ
1.65σ
0
1σ
2σ
DEVIATIONS FROM NOMINAL FOR EACH PARAMETER

FIGURE 6